



## Green Finance Instruments and Sustainable Industrial Transformation in the Age of Industry 5.0

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### ABSTRACT

Recently, digital transformation has become a recognized critical facilitator of the environmental, social, and governance (ESG) performance. However, this transformation remains fragmented across the sustainability, finance, management, and technology literature. This study offers a bibliometric analysis of 478 publications (2016–2026) drawn from 155 sources, employing a PRISMA-based selection process, followed by a

performance analysis and science mapping. The rapidly annual growth, with the research output of 52.04%, is concentrated geographically, particularly in China. The co-citation and keyword co-occurrence analyses reveal the converging thematic streams, encompassing the digital transformation, ESG performance, sustainability reporting, green finance, green innovation, and industry 5.0 transitions. The conceptual mapping indicates a shift from a broad digitalization discourse toward the specialized topics, such as the digital ESG, AI-enabled sustainability systems, and resilience-focused transition frameworks. The study identifies the structural imbalances in the geographic representation and conceptual fragmentation, offering a foundation for future theory-building, comparative empirical studies, and policy-oriented inquiry into the digital pathways for a sustainable transition.

**KEYWORDS:** Digital transformation, green finance, sustainability transition, industry 5.0

### INTRODUCTION

Digital transformation is fundamentally reshaping firms, industries, and markets, and has emerged as a central driver of strategic renewal and sustainable value creation (Chang et al., 2022; Dhayal et al., 2023; Lin & Xie, 2025). Meanwhile, the issue of environmental, social, and

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governance (ESG) has become central to corporate legitimacy and performance (Bindeebe et al., 2025; Meng et al., 2022; Zhou et al., 2025). These two developments now intersect in the increasingly significant ways. However, this digital paradigm is not without inherent risks; rapid implementation can exacerbate environmental challenges, such as e-waste and high energy consumption. It also introduces the complex socio-ethical concerns, including the data privacy risks, algorithmic bias, and workforce displacement.

The companies' choice to digital technologies enhances sustainability. Such technologies are artificial intelligence, blockchain, big data, the Internet of Things (IoTs), and digital twins (Liu & Wang, 2025; Munir et al., 2023; Quttainah & Ayadi, 2024; Silva et al., 2024). These tools have the capability of enhancing traceability, quality of reporting, monitoring, and efficient operation. They are also capable of enhancing the superior ESG governance and more reasonable sustainability statements (Chen et al., 2024; Pu, 2025; Quiroz-Flores et al., 2023; Saxena et al., 2022). However, realizing the sustainability benefits of digital transformation is not automatic. It requires a strategic and integrated approach that aligns the digital investments with the ESG goals and stakeholder expectations. The companies need to carefully consider the ethical implications of digital technologies, such as the data privacy, algorithmic bias, and job displacement. They must also ensure that the digital solutions are designed and implemented in a way that promotes the inclusion, resilience, and long-term value creation for all stakeholders.

Recent studies are evident that digital transformation has the potential to enhance the performance of the ESG (Chen & Ren, 2024; Sang et al., 2025). The environmental outcomes are particularly supportive. The social and governance

gains, however, often tend to be conditional. They rely on the sound competency, regulation, and ethical control (Xie et al., 2024; Zhou et al., 2025). This implies that there is a significant, yet not a homogeneous, digital-ESG connection. Consequently, the relationship between digital transformation and ESG performance is nuanced, exhibiting a substantial variability rather than a uniform effect.

The sustainable finance is also determined by digital transformation. The green finance can be supported by fintech, blockchain, artificial intelligence, and other systems to decrease the level of information asymmetry and enhance transparency (Roy & Vasa, 2025; Zaid et al., 2025). They can also be used to scale the low-carbon investments in renewable energy, green buildings, and sustainable infrastructure (Liu et al., 2021; Naderi & Tian, 2022; Ozili, 2022). At the same time, the AI-based financial systems are now ready to contribute to the carbon accounting, sustainable reporting, and zero-carbon business models (Oyewole et al., 2024; Rane et al., 2024). Despite these benefits, this digital transition faces the critical limitations. The substantial energy demands of high-performance computing required for these technologies can paradoxically increase the carbon footprints.

It is another significant stream, which links digital transformation to the green innovation and industrial transition. It has been reviewed that the digital tools can promote the green innovation, the circular economy, and the carbon-neutral industrial routes (Cagno et al., 2025; Yan et al., 2025). This is eminent in the transition of industry 4.0 into industry 5.0. The sustainability, resilience, and human centricity will be the key objectives in such a shift (Aheleroff et al., 2022; Ghobakhloo et al., 2024; Turner et al., 2022). Conversely, some literature highlights the potential contradictions,

noting that the environmental footprint of digital infrastructure, particularly regarding the high energy demand and e-waste, may paradoxically offset the intended sustainability gains.

Such growing literature is encouraging. Yet it is also fragmented. The published papers are found in the journals related to finance, management, sustainability, accounting, operations, and technology (Florez-Jimenez et al., 2024; Negri et al., 2021). Various reviews are concerned with the small subthemes. These are digital ESG, green fintech, sustainability reporting or industry 5.0. There are very few studies that map the larger body of knowledge in these interconnected areas (Borchardt et al., 2022; Kannan & Gambetta, 2025; Silva et al., 2024). Critically, the prior syntheses remain confined to the narrow disciplinary or geographic boundaries. With a scholarly attention heavily concentrated in the advanced economies, it is still underexplored how the digital-ESG interplay manifests across the emerging markets and divergent institutional settings.

Such a gap is important as the field is expanding at a fast rate. The current dataset consists of 478 articles that have 155 sources published during 2016-2026. It also depicts that its growth rate is 52.04% per annum. These figures suggest that this is a vibrant, yet solidifying field of research. The bibliometric analysis comes in handy in this kind of setting. It can define the dominant contributors, underlying themes, intellectual foundations, and future.

In this paper, the bibliometric study of research has been conducted on digital transformation and the sustainability outcomes relating to ESG. It traces the development, organization, and thematic change of the field. It also determines the key contributors, prevailing themes, and new research possibilities. Thus, the primary goal of this study is to conduct an

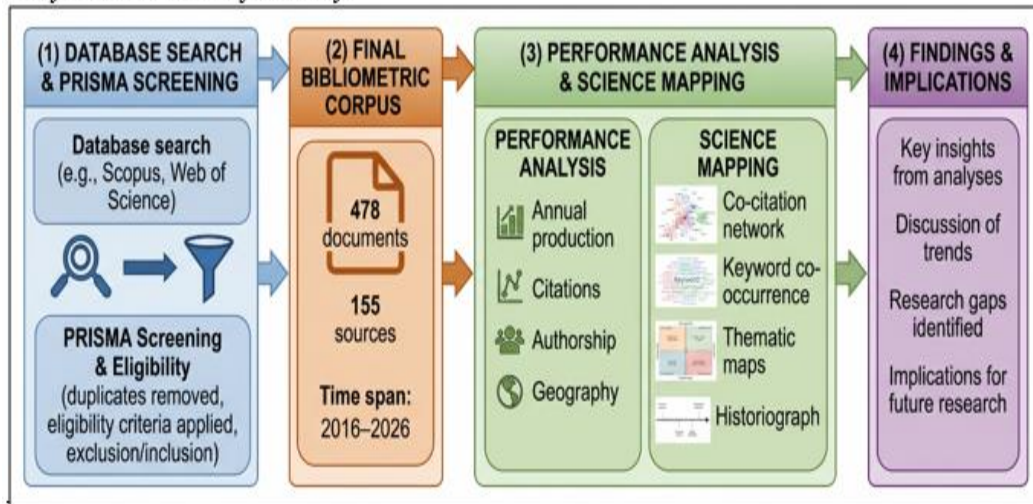
extensive bibliometric mapping on digital transformation and the ESG-related sustainability outcomes, aiming to analyze the performance, intellectual structure, social structure, and development of concept of the field.

This study has several limitations that should be acknowledged. First, the bibliometric corpus is drawn from a single database (Web of Science), which may exclude the relevant studies indexed in Scopus, Google Scholar, or other discipline-specific repositories. Second, the findings are bounded by the chosen search strategy and timeframe (2016–2026), which may not fully capture the earlier foundational works or the most recent publications. Third, the bibliometric methods are well-suited for mapping the structural and thematic patterns but cannot establish the causal relationships or assess the substantive quality of individual studies. These limitations define the scope within which the results should be interpreted and suggest the complementary approaches for future research.

## RESEARCH METHODS

This study has employed a systematic review, using the PRISMA framework. The design was based on a combination of two complementary elements. The former consisted of a quantitative bibliometric analysis of the entire dataset, while the latter involved a qualitative, targeted reading of the major included studies. This dual approach enhanced both the breadth of the analysis and the depth of interpretation. This methodological triangulation offers a robust framework for discerning the overarching trends and granular insights within the complex interplay of green finance instruments and sustainable industrial transformation in the industry 5.0 era.

The final corpus had 478 documents which were published between 2016 and 2026 using 155 sources. The dataset consists of 24,544 cited references, and

**Figure 1***Analytical Framework of the Study*

1,461 authors. The rate of field growth is 52.04 percent. These attributes showed that the subject has large enough to undertake a strong bibliometric mapping.

The bibliographic database was assembled based on the records of Web of Science-format in the plain-text format exported in the Clarivate Analytics. The metadata needed to conduct a bibliometric analysis was retained in this export format. It had the authors, titles, abstracts, affiliations, source titles, author keywords, Keywords Plus, and cited references.

The search strategy was aimed at finding the overlap between digital transformation and the sustainability outcomes related to the ESG. The query was used in order to safeguard that conceptual breadth through a combination of digital terms with other related sustainability terms. They were the ESG, green finance, green innovation, sustainability reporting, circular economy, and industry 5.0. This wider approach was required since the literature applies the overlapping and not the same labels across fields.

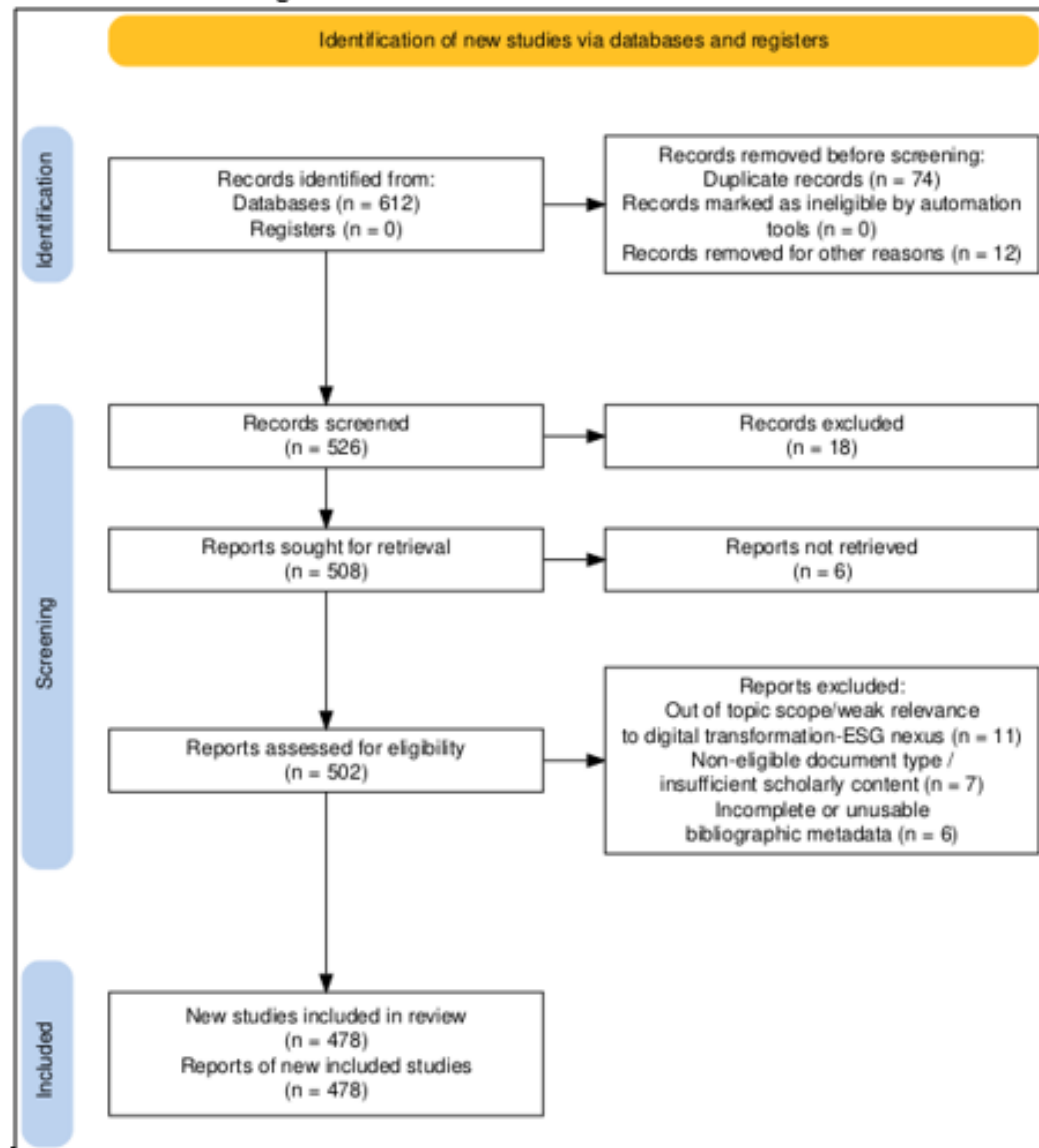
The selection of studies was based on the four PRISMA 2020 phases, including identification, screening, eligibility, and inclusion (Haddaway et al., 2022). During

the identification stage, all the records that were returned by the database search were recorded in a master file. The first cleaning was done to eliminate the duplicate and obviously irrelevant records.

The study selection process has a PRISMA 2020 flow diagram shown in Figure 2. The database searching revealed 612 records. With a total of 74 deleted records as the duplicate records and 12 deleted records due to other reasons, 526 records were filtered according to the titles, abstracts, and keywords. This step eliminated 18 records and 508 reports were retrieved. It did not get six reports and assessed 502 reports to be eligible. During the eligibility phase, 24 reports were rejected, which were not within the scope of the topic, did not fit the document-type criteria or had no bibliographic metadata. The last bibliometric data consisted of 478 documents.

To further fortify the narrative interpretation, a qualitative reading of 28 abstracts and their references was done to complement the bibliometric review. These were not external additions of these papers. They belonged to the enclosed bibliometric corpus.

**Figure 2**  
PRISMA 2020 Flow Diagram



This measure had two functions. To start with, it aided in the drafting of the introduction and thematic literature review. Second, it minimized the risk of excessive interpretation of network clusters which had not been read substantively. This process enhanced the connection between the findings of science mapping and the content of the field.

The combination of performance analysis and science mapping took place in the bibliometric workflow. This bifactor is highly suggested in the bibliometric

studies since it can cover both the productivity tendencies and the knowledge system (Basile et al., 2022; Sarı & Eyüboğlu, 2023). The growth, productivity, and impact were analyzed using a performance analysis. The patterns of collaboration, citation structure, and dissolution of concepts were studied using a science mapping.

The bibliometric analyses (performance analysis and science mapping) were conducted using the bibliometrix R package (R version 4.5.2)

and its Biblioshiny web interface (version Biblioshiny 5.0) (Aria & Cuccurullo, 2017). The workflow of a bibliometrix-based dataset summary generated the dataset summary as can be seen in the descriptive output file of the study. The corpus included 544 Keywords Plus terms and 1,324 author keywords, and this formed a good background to the conceptual mapping. The collaboration profile revealed 3.29 co-authors of the document and 28.03% of international co-authorship, which means that it was an active and networked research area.

The performance measures were the annual scientific production, cumulative growth, annual life cycle, source productivity, author productivity, country productivity, institutional productivity, and citation impact. These products were applied to determine the key contributors and the developmental trend of the field. The visual products that were created on this stage were the annual scientific production, author production over time, source impact, author impact, country production, and institutional contribution maps.

The science mapping was centered on the four dimensions, which are inter-related. The social structure of the field was the first one. This was analysed using the collaboration networks and the country collaboration maps. The second was intellectual structure in the field. It was examined using the co-citation networks, local citation patterns, reference spectroscopy, and historiographic mapping. The third was the conceptual framework of the field. This was analyzed using the co-occurrence of key words, thematic maps, trend topics, factor maps, dendrograms, use of word frequency, tree maps, and three-field plot. The fourth was a relational structure, which was measured by the bibliographic coupling and source-level linkage patterns.

This multilayered method enabled the study to address various types of research

questions. The indicators of performance determined the publisher and place of publication as well as the impact. The networking had revealed the social organization of the field. An analysis based on the citation showed the fundamental intellectual origins of the field. The evolution of the concepts in the field throughout the time was then tracked with the help of the keyword and thematic analyses.

The several units of analysis were utilized in the study. These were the documents, authors, sources, institutions, countries, keywords, and references. The different aspects of the field were captured in various units. The two helped paint a more detailed picture of the evolution of the domain.

To analyze this performance, the key measures were the total publications, growth per year, productivity of the sources, productivity of the authors, number of citations, local citation impact, and production based on country. In the case of collaboration, the key indicators were the co-authorship links, international co-authorship rate, and country collaboration patterns. To analyze it in terms of the intellectual structure, the co-citation, local citation, and historiographic relations were used. To determine the conceptual structure, a frequency of key words, co-occurrence of key words, centrality of themes, centrality, and development of a topic with the time were the most essential indicators.

There were a few measures undertaken to enhance this rigor. To start with, the PRISMA framework guaranteed a clear and auditable study selection (Page et al., 2021). Second, the metadata consistency was enhanced using one bibliographic source author, affiliation, key words, and reference across the authors. Third, the analytical triangulation was possible because of the fusion of performance analysis, science mapping, and specific abstract reading. The

interpretive reliability was also enhanced by this design. The bibliometric maps can reveal a structure, but they do not explain meaning on their own. The qualitative reading of included papers helped anchor the visual patterns in a substantive content. In this way, the study avoided a purely mechanical interpretation of clusters and link strengths.

At the same time, the methodology has its own limitations. Like all the database-dependent reviews, the results reflect the indexing logic of the selected source. The bibliometric outcomes also depend on the metadata quality, search design, and the timing of database extraction. These limits do not weaken the study. Rather, they define the scope within which the findings should be interpreted in the study.

## RESULTS AND DISCUSSION

### Descriptive Profile of the Literature

The bibliometric analysis represents an emerging and fast-growing research area at the convergence of digital transformation and the ESG-related sustainability outcomes. The final corpus was 478 documents published in 2016-2026 in 155 sources, which shows an excellent journal dispersion and the increasing interest of the scholars in the subject. The high annual growth rate of the field was also 52.04, which proves that the output of research has grown rapidly in the recent years.

**Table 1**

*Descriptive Profile of the Dataset*

| Description                        | Results   |
|------------------------------------|-----------|
| <b>Main Information about Data</b> |           |
| Timespan                           | 2016:2026 |
| Sources (Journals, Books, Etc)     | 155       |
| Documents                          | 478       |
| Annual Growth Rate %               | 52.04     |
| Document Average Age               | 1.37      |
| Average Citations Per Doc          | 13.5      |

|                                 |       |
|---------------------------------|-------|
| References                      | 24544 |
| <b>Document Contents</b>        |       |
| Keywords Plus (ID)              | 544   |
| Author's Keywords (DE)          | 1324  |
| <b>Authors</b>                  |       |
| Authors                         | 1461  |
| Authors Of Single-Authored Docs | 24    |
| <b>Authors Collaboration</b>    |       |
| Single-Authored Docs            | 24    |
| Co-Authors Per Doc              | 3.29  |
| International Co-Authorships %  | 28.03 |
| <b>Document Types</b>           |       |
| Article                         | 388   |
| Article; Early Access           | 60    |
| Review                          | 27    |
| Review; Early Access            | 3     |

The descriptive profile also reveals that the field is the majorly article-based. Out of the 478 documents, 388 were articles, 60 were early access articles, 27 were reviews, and 3 were early access reviews. The distribution indicates that the field has a primary motivation in the original scholarly contributions with the possibility of review-based consolidation still existing but sparse.

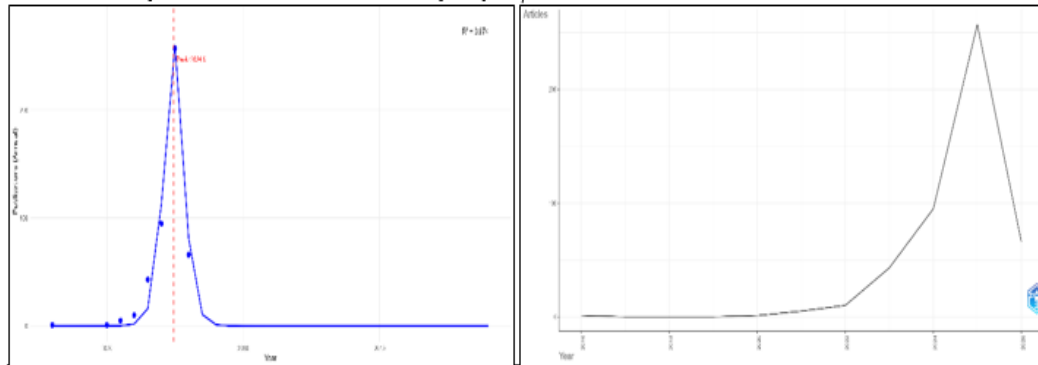
A dynamic and networked research area is also illustrated in the citation and authorship profile. The dataset included 24,544 references, 1,461 authors, and 13.5 citations with each on the average document and an average age of a document of 1.37 years. Moreover, there were 544 Keywords Plus terms and 1,324 author keywords in the corpus, which means that the thematic organization and development of the topics are very diverse and can be further mapped.

### Publication Growth and Influential Contributors

In the temporal analysis, it is observed that the publication activity has a sharp upward trend. The scientific output of the yearly scientists had grown vigorously

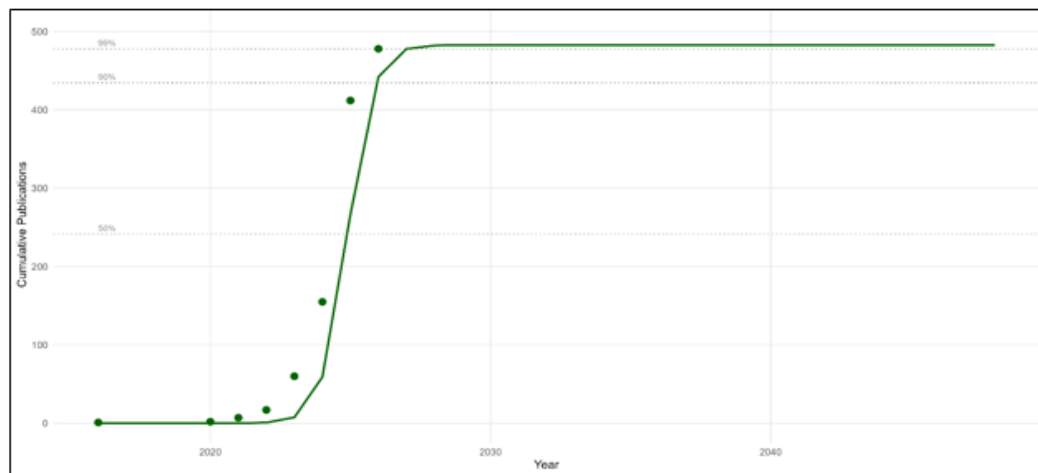
**Figure 3**

*Annual Scientific Production and Annual Life Cycle*



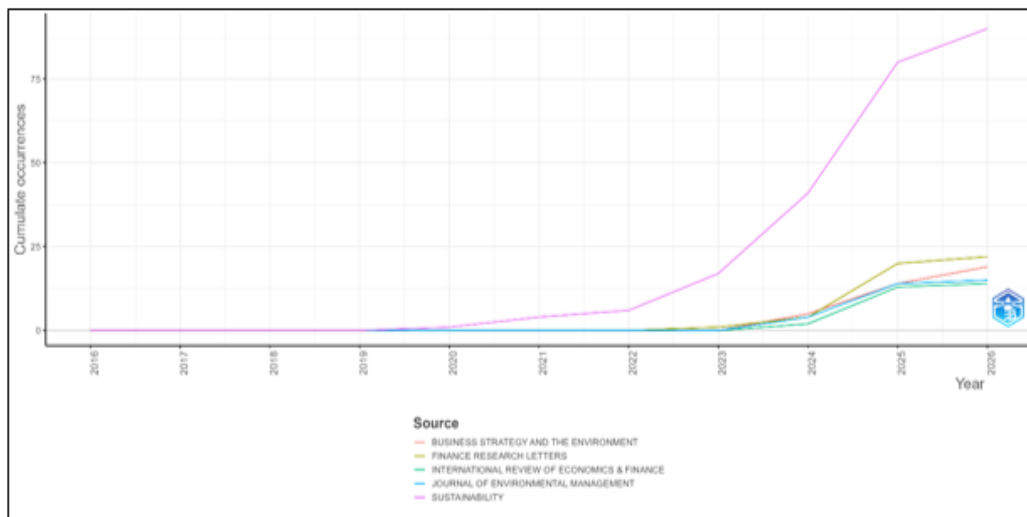
**Figure 4**

*Cumulative Growth*

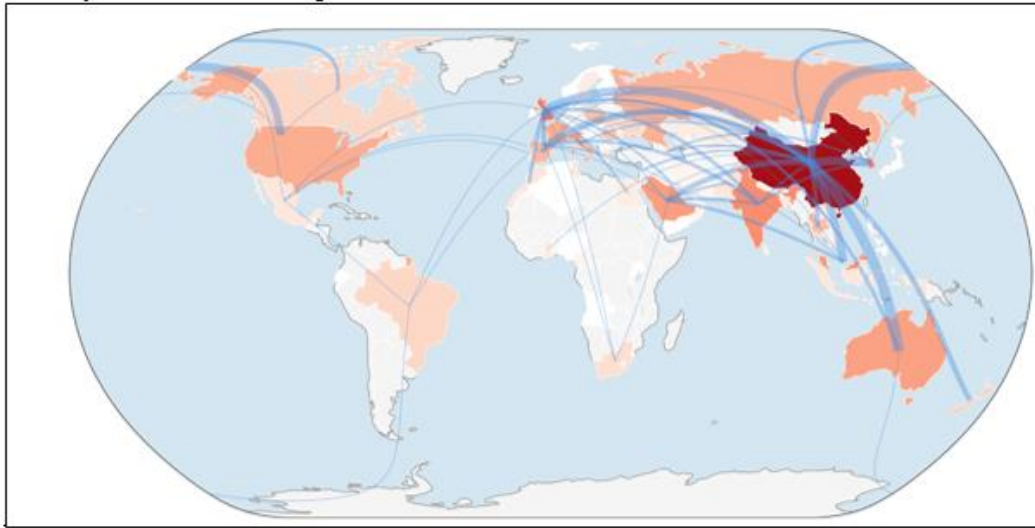


**Figure 5**

*Most Relevant Sources or Source Production over Time*



**Figure 6**  
*Country Collaboration Map*



during the period of the study and the growth trend over the years shows that the field has attained the accelerated growth phase as opposed to a stable maturity stage. It should also be noted that this trend is in line with the increasing academic and policy relevance of digital transformation, the ESG governance, green finance, sustainability reporting, and transition-oriented innovation.

The high growth trend is also indicative of the receptiveness of the field to the new technological and sustainability agendas. More recent research is also the exploring digital ESG models, AI-assisted sustainability platforms, smart reporting platforms, fintech-facilitated green finance, and industry 5.0 migration pathways. This has led to an increase in the amount of literature, as well as its breadth.

This interpretation is supported by the structure of the source. The area is spread out to a broad variety of sources with 155 referenced to make up the final dataset. This extensive spread indicates that the field is still interdisciplinary, and has not yet been intellectually coalesced, but is not dependent on a close set of specialized periodicals.

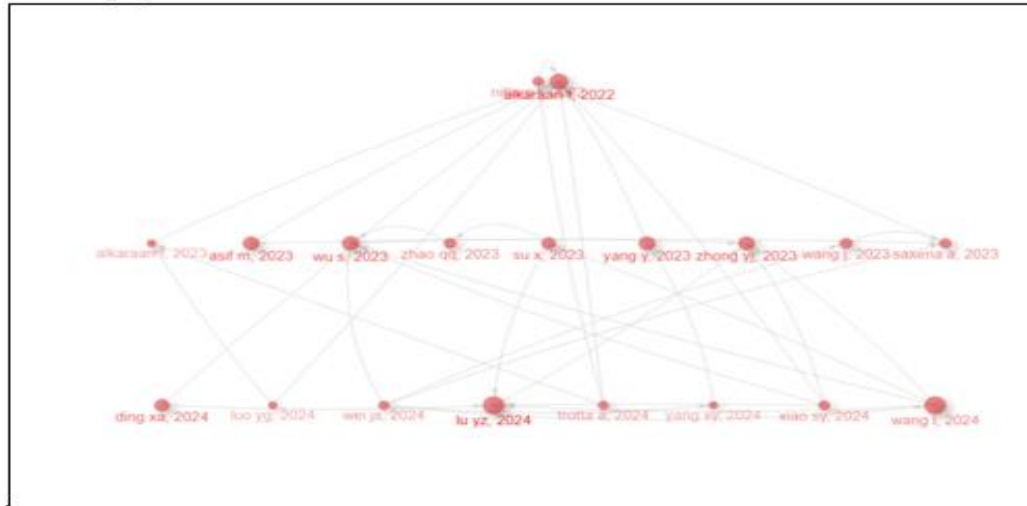
### **Social Structure of the Field**

According to the social structure analysis, this is a cooperative area with the significant international aspect. The number of co-authors per document and the international co-authorship rate in the corpus were 3.29 and 28.03, respectively, which means that team-based and trans-border knowledge production is a vital aspect of the knowledge production in this field. This pattern of collaboration is anticipated in the field that unites sustainability, finance, management, digital technologies, and research of industrial transition.

The partnership, as shown in Figure 5, maps also point to the fact that the field is structured in coherent clusters of visible research centers instead of author clusters. The pattern of collaboration with the country implies that the country is collaboration-driven, yet, in general, the collaboration rate reveals that the integration between the countries is still not even. This is significant as digital transformation and the sustainability-related challenges on the ESG have always been the global entities, but their academic coverage is still seen through the prism of regional and institutional concentration.



**Figure 9**  
*Historiograph*



In the course of time, these sources have been linked with more recent literature about digital ESG, AI-driven systems, intelligent sustainability infrastructures, and industry 5.0.

Such an intellectual framework is particularly significant since it shows that the sphere has left behind the easy stories of digitalization. The knowledge base is now more integrated agenda where the digital tools are being analysed as the enablers of ESG accountability, financing transparency, sustainability innovation, and resilient industrial transformation. In this regard, the structure of citation helps to prove the presence of the coherent and more and more recognizable research area.

Table 2 shows the top authors, publication sources, institutional affiliations, and nationalities in the digital transformation-ESG literature. The output is more or less concentrated on a small segment of contributors with the most productive authors being Chen, Lifeng, and Hussainey, Khaled with five publications each, Alkaraan, Fadi, Kumar, Anil, Lu, Yuzhong and Samadhiya with four publications each and Ashutosh with four publications each. This trend indicates that the discipline is flourishing with the repeated efforts of the few active scholars instead of being controlled by one highly prolific writer.

The distribution at the source level is more concentrated. Sustainability obviously leads in the number of publications with 90 articles as compared to *Finance Research Letters* with 22 articles and *Business Strategy and the Environment* with 19 articles. *Journal of Environmental Management*, *International Review of Economics and Finance*, *Systems and Corporate Social Responsibility*, and *Environmental Management* are other outlets that confirm the interdisciplinary nature of the discipline within the sustainability, finance, and management journals.

**Table 2**  
*Leading Contributors and Publication Outlets in the Digital Transformation-ESG Literature*

**Panel A. Most Relevant Authors**

| Rank | Author              | Articles |
|------|---------------------|----------|
| 1    | Chen, Lifeng        | 5        |
| 1    | Hussainey, Khaled   | 5        |
| 3    | Alkaraan, Fadi      | 4        |
| 3    | Kumar, Anil         | 4        |
| 3    | Lu, Yuzhong         | 4        |
| 3    | Samadhiya, Ashutosh | 4        |
| 7    | Chen, Wanyi         | 3        |
| 7    | Elmarzouky, Mahmoud | 3        |
| 7    | Han, Jie            | 3        |
| 7    | Safi, Adnan         | 3        |

| <b>Panel B. Most Relevant Sources</b>      |                                                              |                 | <b>Panel D. Most Productive Countries</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                |                  |
|--------------------------------------------|--------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|------------------|
| <b>Rank</b>                                | <b>Source</b>                                                | <b>Articles</b> | <b>Rank</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>Country</b> | <b>Frequency</b> |
| 1                                          | Sustainability                                               | 90              | 1                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | China          | 632              |
| 2                                          | Finance Research Letters                                     | 22              | 2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | India          | 50               |
| 3                                          | Business Strategy and the Environment                        | 19              | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | UK             | 47               |
| 4                                          | Journal of Environmental Management                          | 15              | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Russia         | 36               |
| 5                                          | International Review of Economics & Finance                  | 14              | 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | South Korea    | 36               |
| 6                                          | Systems                                                      | 12              | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Italy          | 28               |
| 7                                          | Corporate Social Responsibility and Environmental Management | 11              | 6                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Malaysia       | 27               |
| 7                                          | Frontiers in Environmental Science                           | 11              | 7                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Australia      | 21               |
| 9                                          | International Review of Financial Analysis                   | 8               | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Saudi Arabia   | 20               |
| 9                                          | Sustainable Futures                                          | 8               | 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Ukraine        | 20               |
| <b>Panel C. Most Relevant Affiliations</b> |                                                              |                 | <b>Note.</b> Panels A-C report article counts from the bibliometrix outputs. Panel D reports country frequency values, which may exceed the number of documents because one record can contribute to more than one country count.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                |                  |
| <b>Rank</b>                                | <b>Affiliation</b>                                           | <b>Articles</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 1                                          | Ministry of Education and Science of Ukraine                 | 17              | <p>An apparent attention of the research production can also be seen in terms of the institutional profile. The Ministry of Education and Science of Ukraine is the leader with 17 articles and Nanjing University of Finance and Economics has 13 articles and Central University of Finance and Economics, Wuhan University, and Zhejiang Gongshang University have 11 articles respectively. The fact that Chinese institutions have many of the highest affiliations points to the level of institutional influence of the China-based research actors on the field.</p> <p>The clearest concentration is observed at the country-level. China is by far a leader in the arena with a frequency of 632, and India, UK, Russia, and South Korea rank a way below at a very low level. The following countries also feature in the list of the most productive countries: Italy, Malaysia, Australia, Saudi Arabia, and Ukraine, indicating that the field has already acquired the international distribution, but its production is extremely concentrated on China.</p> |                |                  |
| 2                                          | Nanjing University of Finance and Economics                  | 13              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 3                                          | Central University of Finance and Economics                  | 11              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 3                                          | Wuhan University                                             | 11              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 3                                          | Zhejiang Gongshang University                                | 11              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 6                                          | Dongbei University of Finance and Economics                  | 10              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 7                                          | Chinese Academy of Sciences                                  | 8               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 7                                          | City University of Macau                                     | 8               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 7                                          | Hunan University                                             | 8               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |
| 7                                          | Jiangsu University                                           | 8               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                |                  |

thematic domains. The co-occurrence network keyword suggests that digital transformation is closely related to the ESG performance, green finance, green

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innovation, sustainability reporting, circular economy, and sustainability transitions involving the industry 5.0. Such a trend indicates that digital transformation is not a single technological process that is being addressed in the literature anymore. Instead, it frames digitalization as a strategic and governance process in the context of wider sustainability changes.

industrial transformation, circular economy, and smart systems become more interconnected in the same study area. This convergence is important in that it represents the transition of the disjointed topic clusters to more integrated perceptions of the impact of digital capabilities on the sustainability outcomes on organizational and systemic scales.

**Figure 12**

*Thematic Map*

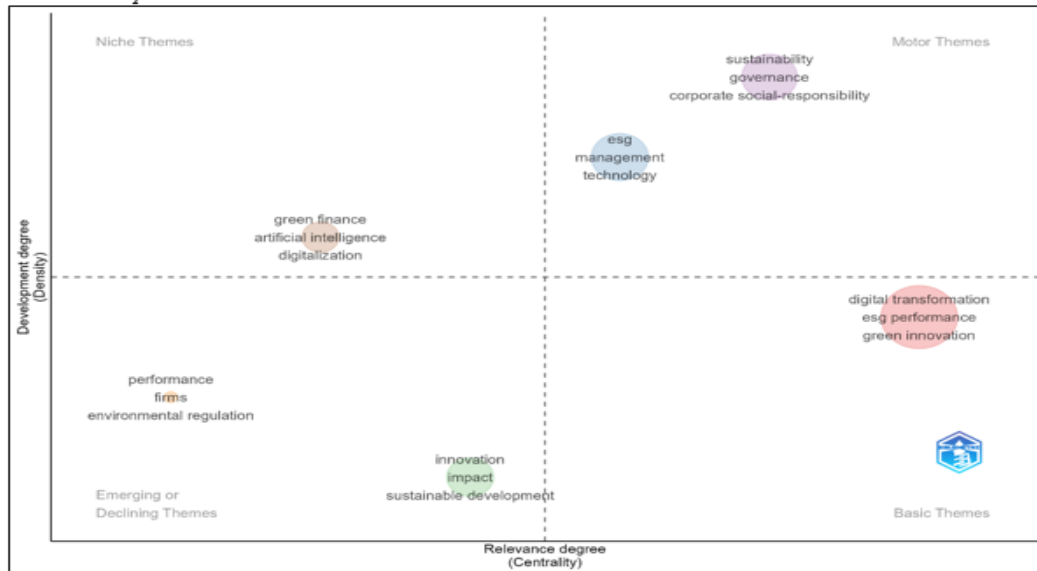


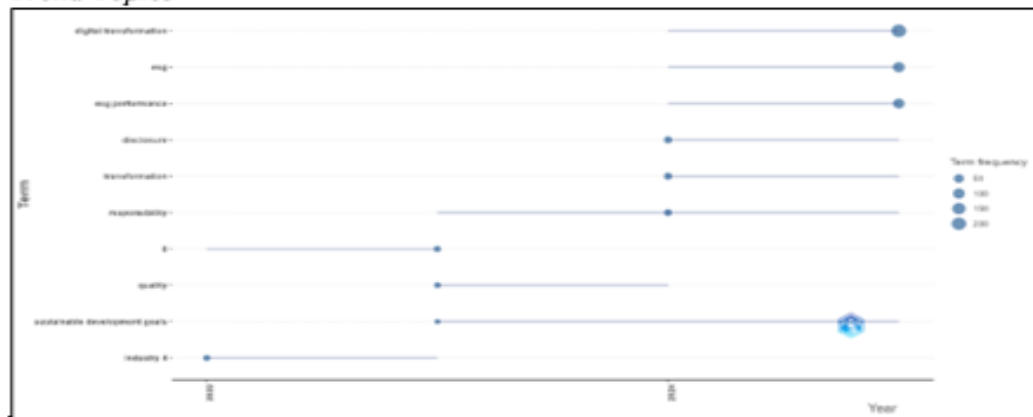
Figure 10: Word Cloud and Tree, Figure 11: Keyword Occurrence, and Figure 12: Thematic Map verify the fact that there are some existing and developing topic clusters in the field. The mature themes seem to focus on the ESG governance, digital reporting platforms, green finance mechanisms, and innovation-driven sustainability roadmaps, whereas the newer themes are connected to AI, smart monitoring systems, digital ESG structures, and resilience-focused transition frameworks. This portrays that the field is evolving profundity in its areas that have been made as well as still assimilating the new technological and policy issues.

There is also good interdisciplinarity that is reflected through the conceptual structure. Its topics related to digital finance and sustainable accounting,

### Thematic Evolution and Emerging Research Directions

The trend analysis shows that the field has shifted away to more specific subjects with the increased application and governance relevance and less general debate on digital transformation and sustainability. There has also been a trend towards the digital ESG, AI-assisted sustainability systems, fintech-enabled green finance, smart ESG monitoring, zero-carbon financial models, and digital approaches towards the green innovation and industry 5.0 transitions. This is an indication that the discipline is becoming more problem-oriented and operative.

Meanwhile, the literature still demonstrates the traces of the thematic concentration and uneven growth. A few of the studies reviewed indicate the prevalence of chosen countries and

**Figure 13**  
*Trend Topics***Table 3**  
*Major Thematic Domains and Representative Studies in the Digital Transformation-ESG Literature*

| Theme                                                                       | Core focus                                                                                                                                                | Representative studies                                                                            | Main insight                                                                                                                                                                                     |
|-----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Digital transformation and ESG performance                                  | Examines how digitalization improves environmental, social, and governance outcomes at the firm level.                                                    | Bindeeba et al. (2025); Kumar and Shah (2025); Hammad et al. (2025)                               | Digital transformation generally improves ESG performance, although the strength of the effect varies by ESG pillar, firm capability, and regulatory context.                                    |
| Digital technologies in sustainability accounting, reporting, and assurance | Focuses on AI, blockchain, IoT, big data, and digital infrastructures for ESG disclosure, reporting quality, and verification.                            | De Silva et al. (2025); Gund et al. (2026); Spilotro et al. (2025)                                | Digital tools enhance transparency, reporting accuracy, real-time monitoring, and sustainability assurance, while also shifting firms from static reporting to more adaptive governance systems. |
| Green finance and sustainable fintech                                       | Explores how digital finance, fintech, AI, and blockchain support green investment, low-carbon financing, and sustainable financial services.             | Ahmad et al. (2025); Vergara and Agudo (2021); Dias et al. (2025); Jaiswal and Satyanish (2025)   | Fintech and digital finance strengthen transparency, reduce information asymmetry, and support low-carbon and sustainability-oriented financing pathways.                                        |
| Green innovation and Industry 5.0 transition                                | Investigates the role of digital transformation in green innovation, circular economy, green supply chains, and carbon-neutral industrial transformation. | Dhayal et al. (2023); RDhayal et al. (2025); Song et al. (2025)                                   | Digital transformation is increasingly linked to Industry 5.0, green innovation, and net-zero transition pathways, especially through AI, green supply chains, and circular practices.           |
| Sustainability, resilience, and supply chain transformation                 | Connects sustainability goals with resilience, risk management, and digitalized global supply chain governance.                                           | Meng et al. (2025); Deirmentzoglou et al. (2026)                                                  | The literature emphasizes the sustainability-resilience nexus, ESG compliance, and the role of digital transformation in managing trade, logistics, and supply chain risks.                      |
| Regulation, governance, and institutional alignment                         | Examines legal design, governance frameworks, public policy, and institutional support mechanisms for ESG and digital sustainability transitions.         | Metin (2024); Deirmentzoglou et al. (2026); Kolupaieva and Lindahl (2025); Khussain et al. (2025) | Regulatory coherence, governance design, and institutional support are essential for translating digital capabilities into durable ESG and sustainability outcomes.                              |

**Table 4**  
*Summary of Bibliometric Findings and Research Implications*

| <b>Bibliometric dimension</b> | <b>Key finding</b>                                                                                                                                                                               | <b>Interpretation</b>                                                                                                                  | <b>Research implication</b>                                                                                                                                 |
|-------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Field growth                  | The field includes 478 documents published during 2016–2026, with an annual growth rate of 52.04%.                                                                                               | Research on digital transformation and ESG-related sustainability outcomes is expanding rapidly and has entered a strong growth phase. | Future studies should move from descriptive expansion toward stronger theory building, causal testing, and comparative designs.                             |
| Source structure              | The literature is distributed across 155 sources, although Sustainability alone accounts for 90 articles.                                                                                        | The field is interdisciplinary but also partially concentrated in a few highly visible journals.                                       | Scholars should diversify outlet strategies and strengthen cross-disciplinary dialogue across sustainability, finance, management, and technology journals. |
| Authorship pattern            | The dataset includes 1,461 authors, with the most productive authors contributing 5 or 4 articles each.                                                                                          | The field is not dominated by a single author, but by a small group of recurring contributors.                                         | More cumulative research programs and stable scholarly networks are needed to consolidate the field's intellectual core.                                    |
| Collaboration structure       | The corpus shows 3.29 co-authors per document and 28.03% international co-authorship.                                                                                                            | The field is collaborative and internationally connected, but cross-border integration remains moderate rather than fully mature.      | Future work should increase international collaboration, especially across underrepresented regions and institutional contexts.                             |
| Geographic concentration      | China leads country production by a wide margin, followed by India and the UK.                                                                                                                   | Research output is internationally spread, but strongly concentrated in a limited number of countries.                                 | Greater empirical attention is needed in Africa, South Asia, transition economies, and other less represented settings.                                     |
| Institutional concentration   | Leading affiliations include the Ministry of Education and Science of Ukraine, Nanjing University of Finance and Economics, and several major Chinese universities.                              | Institutional leadership is visible but concentrated in a limited number of higher-output research centers.                            | Broader institutional participation would improve diversity in methods, contexts, and theoretical perspectives.                                             |
| Knowledge base                | The dataset contains 24,544 references and shows an interconnected citation structure across digital transformation, ESG, green finance, green innovation, and sustainability reporting studies. | The field has developed through convergence across several adjacent literatures rather than from a single disciplinary tradition.      | Future research should integrate these streams more explicitly through shared frameworks and cross-domain theory development.                               |
| Conceptual diversity          | The corpus includes 544 Keywords Plus terms and 1,324 author keywords.                                                                                                                           | The field has a broad and evolving thematic vocabulary, indicating both richness and fragmentation.                                    | Researchers should refine constructs, improve conceptual consistency, and clarify the boundaries among related themes.                                      |

|                     |                                                                                                                                                                                     |                                                                                                                           |                                                                                                                                                       |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Dominant themes     | Major themes include digital transformation and ESG performance, sustainability reporting, green finance, fintech, green innovation, circular economy, and Industry 5.0 transition. | The field has moved from broad digitalization debates toward applied sustainability, governance, and transition concerns. | Future studies should examine how these themes interact across firm, industry, financial, and policy levels.                                          |
| Emerging directions | Recent topics increasingly emphasize digital ESG, AI-enabled sustainability systems, smart monitoring, zero-carbon finance, and resilience-oriented transition pathways.            | The field is becoming more operational, data-driven, and policy-relevant.                                                 | Promising directions include ethical AI governance, digital disclosure quality, sector-specific applications, and multi-country comparative research. |

industries, particularly that related to the research of digital transformation and green innovation, digital ESG, and sustainable fintech finance. It means that the expansion in the future will be probably achieved through the enhanced regional representation, increased diversification of the empirical side, and more detailed drawing comparisons across the sectors.

Table 3 gives the significant thematic areas that organize the field. The literature is pegged on six intimately related spheres including digital transformation and ESG performance; sustainability reporting and assurance; green finance and sustainable fintech; green innovation and industry 5.0 transition; sustainability and supply chain resilience; and regulation and governance alignment. Collectively, these themes indicate that the field is no longer concerned with the general debates over digitalization but deals with more practical concerns regarding the quality of reporting, green financing arrangements, resilient operations, industrial decarbonization, and institutional provision to the sustainability transitions.

Table 4 summarizes the key bibliometric results and their prospective implications to the study. The findings indicate a fast-expanding discipline, extensive dispersion of sources, collaborative authorship, and high level of thematic heterogeneity, but the obvious concentration of journals, institutions, and

nationwide. The synthesis also shows that the field has developed due to an integration of multiple areas that are closely connected, in particular, with the digital transformation, the ESG performance, sustainability reporting, green finance, green innovation, and the transition research associated with the industry 5.0. Meanwhile, the table outlines some critical future priorities, such as an increased integration of theory, increased geographic dispersion, increased international cooperation, and conceptual alignment in subfields.

The current findings indicate that the study on digital transformation and ESG-related sustainability outcomes is growing at a fast pace, as 478 articles were published in 2016-2026 and the growth rate of 52.04 articles is observed each year. Such a trend is in line with the recent review-based articles that address the field as rapidly expanding and gaining more significance in the area of sustainability governance, green finance, and industrial transition (Mahmoud & Surwanti, 2025; Narayanan & Pradhan, 2023; Truffer et al., 2022; Yuan, 2025). The present results, however, give a reason to believe the existence of a more complicated picture than the previous reviews. Although in the previous literature, the primary focus has been on the growth, especially on the subdomains (such as digital ESG, green innovation, or sustainability reporting), the current mapping suggests that the process

is growing across a far broader and more fragmented field (Conde-Torres et al., 2026; Hajkowicz et al., 2023; Vega et al., 2022). It suggests that the study of digital transformation and the ESG sustainability outcomes has significantly impacted the green finance in the age of industry 5.0.

## CONCLUSION AND IMPLICATIONS

The paper mapped the digital transformation and ESG-related sustainability outcomes literature, demonstrating that the niche has evolved into an interdisciplinary and rapidly expanding research area. The evidence suggests a high publication increase, wide journal scattering, healthy teamwork, and growing thematic convergence toward the ESG performance, green finance, sustainability reporting, green innovation, and industry 5.0 transition pathway. Meanwhile, the discipline has not yet achieved an intellectual solidarity or spatial diversification of its production, whereby the majority of scholarly work is highly concentrated in a few countries and organizations. Such results indicate that the sphere is transitioning between the stage of growth to the stage of early maturity, which needs a greater theoretical synthesis and a more comprehensive range of empirical evidence.

This study makes a distinctive contribution by offering the first comprehensive bibliometric synthesis that integrates the previously fragmented sub-literatures on digital transformation, ESG performance, sustainability reporting, green finance, green innovation, circular economy, and industry 5.0 transitions into a single analytical framework. By mapping 478 documents spanning a decade of accelerating scholarship, the study provides a structured and reproducible account of how this interdisciplinary field has developed, where its intellectual foundations lie, and what conceptual directions are emerging. These contributions address a critical

methodological gap: the absence of a systematic, broad-scope mapping of this rapidly growing research domain.

There are several implications of the study. In theory, it demonstrates that digital transformation is to be interpreted not merely as a technologic process, but as a governance, funding, and enabling capacity of transition, which governs the sustainability results on various levels. In practice, the findings indicate that the managers ought to prepare the digital investments in line with the ESG strategy, reporting, and innovation priority instead of regarding digitalization as an independent modernization agenda. To the policymakers, the results provide a closer insight at the necessity to have the stronger digital spaces, more regulating frameworks, and more consistent institutional underpinnings to make sure that the digital tools can convert into the plausible and scalable sustainability transformations.

These limitations should be overcome in future research in several ways. To begin with, the researchers ought to come up with more integrative frameworks that can explain how these digital abilities an impact on the ESG have results in the firms, sectors, and even policy systems. Second, the comparative, context-sensitive research is required in the greater amounts and in the underrepresented areas like Africa, South Asia, and transition economies. Third, the upcoming research must look into the upcoming trends more carefully, such as the ethical AI governance, quality of digital ESG disclosure, zero-carbon finance, and application in the specific sectors, such as finance, manufacturing, healthcare, and supply chains. Generally, the field is highly endowed with further conceptual improvement and expansion of empirical knowledge.

### CONFLICT OF INTEREST

The authors declare that they have no competing interests (financial or non-financial) that could have appeared to influence the work reported in this paper.

### AUTHOR CONTRIBUTIONS

All authors have contributed equally to prepare this paper.

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