

Review Article

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**GREEN INNOVATION STRATEGIES FOR
ENHANCING SUSTAINABLE PERFORMANCE: A
BIBLIOMETRIC ANALYSIS AND RESEARCH
AVENUES**

Background. Amidst an increasingly dynamic global economic landscape, understanding how green innovation contributes to sustainable performance remains a crucial research agenda. Despite its growing popularity, existing studies continue to report fragmented and divergent outcomes regarding the effects of green innovation on sustainable performance.

Purpose. This study presents a systematic literature review and bibliometric analysis of 211 peer-reviewed articles published between 2019 and 2025, sourced from the Scopus and ScienceDirect databases.

Findings. Utilising VOS Viewer software, this research draws on the epistemological construction of the disciplines. It identifies six thematic clusters: (1) eco-environmental innovation and sustainable finance, (2) CSR and green supply chains for business performance, (3) circular economy and sustainable supply chain development, (4) digital transformation and ESG-oriented sustainability, (5) green and sustainable manufacturing research landscape, and (6) AI-based innovation and ESG performance. For the keyword co-occurrence analysis, a complete counting method was applied with a minimum keyword occurrence threshold of 5 to reduce analytical noise and enhance map interpretability, which was considered appropriate given the final dataset size. Network normalisation and visualisation were performed using the association strength method, following the standard VOSviewer procedures to ensure transparency and reproducibility.

Implications. This study shows a shift from a fundamental conceptualisation of green innovation toward its strategic alignment with dynamic capabilities, absorptive capacity, and digital technologies, such as artificial intelligence, that enable green, digital, and resilient economic transitions. This study provides a holistic picture of the scope, geographic distribution, and temporal evolution of green innovation research and reveals gaps in geographic and sectoral coverage, particularly in emerging economies.

Keywords: Bibliometrics, Circular Economy, Environment, Green Innovation, Sustainable Performance.

1. Introduction.

Amid increasingly complex global economic dynamics, green innovation (GI) is becoming a key driver of organisational performance and long-term business sustainability (Hafeez et al., 2025; Yang et al., 2025). Thus, green innovation, which encompasses the refinement of environmentally conscious creations, processes, and management practices, has attracted significant attention from researchers and practitioners due to its capacity to drive fundamental transformations within organisations (Arsawan et al., 2023; Chaudhuri et al., 2023).

The existing scholarly literature acknowledges the crucial role of green innovation in various areas, such as new products (Cooper, 2024; Mehralian et al., 2024), organisational knowledge (Pett et al., 2025), and business performance, which collectively contribute to sustainability (Le et al., 2022).

Researchers have established a link between green innovation and business performance in various industry domains. For example, in the SME sector, GI drives innovative work behaviour (Tello-Gamarra & Fitz-Oliveira, 2023; Valdez-Juárez et al., 2022), as well as business performance and competitiveness (Madzík et al., 2024; Moreira et al., 2024). Conversely, in the hospitality sector, green innovation increases customer engagement and loyalty (Alam et al., 2025; Cuesta-Valiño et al., 2025; Hung, 2023).

Furthermore, in developing economies, green innovation is categorised as a strategy that integrates digital and resilient elements to achieve net-zero and a bioeconomy (Mehmood et al., 2025; Solarte-Montufar et al., 2021). The success of green innovation depends on both inbound and outbound knowledge flows, which enable organisations to generate innovative ideas (Lin et al., 2024).

Previous studies have explored the implementation of green innovation across countries, emphasising technology adoption through alliances between corporations, state agencies, higher education institutions, and scholarly centres to improve performance outcomes (Valdez-Juárez et al., 2025).

Furthermore, green innovation functions as a reciprocal exchange in which cognition is absorbed and disseminated in organisations, generating novel and progressive ideas (AL-Shboul, 2025).

This shows that green innovation is an important pillar for improving performance and sustainability at both the individual and organisational levels. The antecedents of green innovation as a pivotal driver of sustainability remain fragmented and inconsistent (Azzolini et al., 2025; Hafeez et al., 2025; Salah & Ayyash, 2024). Some studies (Azhar Mohd Harif et al., 2022; Costa et al., 2023; Santoro et al., 2020) found significant correlations among green innovation, product innovation, process efficiency, and marketing strategy, while others highlighted technological limitations that hinder the effective management of green innovation processes. In addition, Lai et al. (2022) and Rauter et al. (2019) reveal contradictory findings depending on the innovation approach adopted and the organisation's readiness to manage external knowledge.

These inconsistent findings suggest the need for further investigation, providing a strong rationale for conducting a systematic literature review. The literature on green innovation strategies provides a comprehensive view of the extent to which relevant research enriches the body of knowledge. Furthermore, knowledge gaps indicate that there is a dearth of explicit studies that map the linkage between GI and sustainable performance (henceforth SP) (Le et al., 2022; Sarango-Lalangui et al., 2023), presenting an opportunity to conduct a synthesis of the literature and provide an exhaustive overview of relevant literature development that links green innovation and its antecedents to sustainable business performance. In addition, given the important role in the development of organisational sustainability values, green innovation and its drivers can bridge the gap between internal and external stakeholders of an organisation in enriching their innovation towards sustainable competitiveness (Arsawan et al., 2023) and simultaneously contribute positively to environmental conservation efforts (Arsawan et al., 2024).

Furthermore, there is an imbalance in the geographical and sectoral distribution of green innovation studies, which are predominantly conducted in developed countries (Brodny & Tutak, 2024). These countries invest in human and intellectual capital to enhance their technical capabilities and knowledge (Haldorai et al., 2023) in designing green innovations that can enrich new product development (Mehralian et al., 2024) while enhancing environmental values and efforts towards sustainability performance (Ratnawati et al., 2024).

Previous research has focused more on green innovation driving digital transformation in developed countries (Azzolini et al., 2025; Hafeez et al., 2025). However, green innovation is also needed in developing countries to improve their performance and competitiveness (Dahri et al., 2025; Sabando-Vera et al., 2025; Sarango-Lalangui et al., 2023). Digital transformation is the backbone of innovation because it is considered to have a strategic role in accelerating change and flexibility (Djiu et al., 2024), cost efficiency (Ratnawati et al., 2024; Siddik et al., 2023; Yadegaridehkordi et al., 2023), improving service quality (Feng & Li, 2025), service reach, and ease of access (Siddik et al., 2023).

Finally, there is a lack of bibliometric mapping that addresses strategic questions, namely: what is being researched, where studies are conducted, when trends emerge, and where we currently stand regarding green innovation and sustainable business performance (Sabando-Vera et al., 2025). Therefore, conducting a literature review on this topic will provide a comprehensive overview and offer insights into opportunities for conducting relevant research, building author networks and exploring contemporary ideas in relevant areas. Drawing on the above knowledge gaps, this study addresses the following research questions.

RQ1. How has the thematic structure of green innovation research related to sustainable performance evolved, as revealed through co-word analysis and thematic evolution mapping?

RQ2. What are the core intellectual foundations and dominant knowledge clusters of the green innovation–sustainable performance literature, as identified through citation and co-citation network analyses?

RQ3. What research gaps and future research opportunities emerge from bibliometric clustering, overlay visualisation, and collaboration network analysis?

2. Literature Review.

Green innovation (GI) has increasingly emerged as a strategic mechanism for enhancing organisational competitiveness and sustainable performance, encompassing product, process, and managerial innovations to improve resource efficiency and reduce environmental impact. Previous studies have shown that green innovation strengthens knowledge capabilities and drives superior performance across sectors, particularly SMEs and services (Bahoo et al., 2023; Mehmood et al., 2025), and is pivotal in supporting digital-driven transitions toward green and net-zero economies in developing countries (Schiavone et al., 2022; Tabares et al., 2025).

Despite the growing literature, empirical evidence on the relationship between green innovation and performance is inconsistent. Some studies confirm its positive effects on innovation and operational efficiency (Hunjra, 2025), while others highlight technological limitations, organisational readiness, and capability gaps as significant barriers to effective GI implementation (Haq et al., 2025). Furthermore, the literature is geographically skewed toward advanced economies with superior digital and technological infrastructure, underscoring the need for a deeper examination of emerging economies (Appiah-Kubi et al., 2024; Pilav-Velic et al., 2024).

Green innovation research increasingly intersects with green supply chain management (GSCM), corporate social responsibility (CSR) (Le et al., 2022), and circular economy strategies (Arsawan et al., 2024). The integration of green innovation with CSR and GSCM enhances legitimacy, efficiency, and environmental performance (Chaudhuri et al., 2023; Shahzad et al., 2024), and circular economy practices extend the value of GI through resource regeneration and supply chain resilience (Le et al., 2022; Wei et al., 2024).

Recent developments in digital technologies, such as big data, blockchain, cloud systems, and artificial intelligence, have heightened the strategic importance of green innovation by enhancing ESG transparency, environmental monitoring, and data-driven decision-making (Jalil et al., 2025; Y. Liu et al., 2025). However, digital capability gaps and weak data governance remain significant obstacles, particularly in developing countries.

In addition to the environmental and economic dimensions, the social pillar of sustainability remains comparatively underexplored in green innovation research, despite its fundamental role within the Triple Bottom Line framework (Cavaliere et al., 2024). From a social sustainability perspective, green innovation contributes to employee well-being, decent working conditions, community engagement, and stakeholder trust, particularly when integrated into corporate social responsibility initiatives and green supply chain management practices (Khan et al., 2023; Niu et al., 2024). These socially oriented mechanisms support social legitimacy and inclusive value creation, especially in labour-intensive and SME-dominated contexts. Social performance outcomes, such as employee welfare, social equity (Sætra, 2024), and community impact, remain less systematically conceptualised and empirically examined than environmental and economic indicators, highlighting the need for a more balanced Triple Bottom Line perspective.

Furthermore, comprehensive bibliometric mapping and longitudinal evidence capturing the evolution, thematic shifts, and current positioning of green innovation research remain limited. These gaps underscore the need for a systematic bibliometric synthesis to clarify research trajectories, identify thematic clusters, and uncover future avenues that can enrich theoretical and practical contributions to GI and sustainable performance.

3. Methodology.

To achieve the research objectives, this study employed a systematic literature review (SLR) guided by the PRISMA framework, which encompasses the identification, screening, eligibility, and inclusion phases.

During the identification phase, a comprehensive literature search was conducted in the Scopus and ScienceDirect databases using the following search string (“green innovation” and “sustainable performance”). Scopus was used as the primary indexing database due to its multidisciplinary coverage and standardised metadata. ScienceDirect was searched using the same query to support full-text verification and capture potentially relevant Elsevier-hosted or early-access articles. However, it was not treated as an independent sampling source to avoid publisher bias. Records from both platforms were merged, and duplicates were removed based on DOI, title, and author matching prior to screening. The search was limited to publications between 2019 and October 2025 to capture recent developments and emerging trends in the field, and restricted to peer-reviewed journal articles written in English to ensure academic rigour and comparability.

Furthermore, the search was confined to the following main subject areas: (1) Business, Management and Accounting; (2) Environmental Science; (3) Energy; (4) Economics, Econometrics and Finance; (5) Social Science; (6) Engineering; and (7) Computer Science. The data for 2025 provides a basis for predicting future research trends in green innovation by analysing keywords and their relationships with other constructs. The initial search yielded 788 records, which were exported in Research Information System (ris*) format and managed using Mendeley.

During the initial screening, duplicate records were eliminated, and the titles and abstracts were examined to determine their alignment with the objectives of this review. Articles were excluded when not directly related to green innovation or sustainable performance, or when they demonstrated superficial keyword matches. This process excluded 468 articles, leaving 320 articles for further evaluation. A full-text assessment was conducted during the eligibility phase. Articles were excluded if they did not substantively address green innovation or sustainable performance, lacked empirical or methodological rigour, or were misaligned with the scope.

Following this assessment, 109 articles were excluded, resulting in a final dataset of 211 articles included in the review. From the final dataset of 211 articles, 103 studies explicitly modelled or empirically examined the relationship between green innovation and sustainable performance. The remaining articles address adjacent themes such as ESG, CSR, circular economy, green supply chains, digital sustainability, and environmental innovation capabilities without directly testing the GI–SP linkage.

After the final selection of articles, bibliometric and content analyses were conducted using VOSviewer version 1.16.20 to analyse and visualise the bibliographic data systematically. VOSviewer was used to examine keyword co-occurrence patterns, citation relationships, authorship and collaboration networks, and publication trends, enabling a structured assessment of the intellectual structure and thematic evolution of the literature.

For the keyword co-occurrence analysis, the full-counting method was used, with a minimum keyword occurrence threshold of five to reduce noise and enhance map interpretability. This threshold was considered appropriate given the final dataset of 211 articles, as it balanced analytical clarity with the inclusion of thematically relevant and emerging research topics. Network normalisation was performed using the association-strength method, following the standard VOSviewer procedures. This analytical approach facilitated the identification of dominant research streams, emerging topics, and underexplored areas, thereby providing an empirical basis for identifying research gaps and positioning the study within the domains of green innovation and sustainable performance. (Dzhunushalieva & Teuber, 2024).

Figure 1 presents the PRISMA flow diagram of the research protocol, from the initial identification of records to the final inclusion of 211 key articles for analysis.

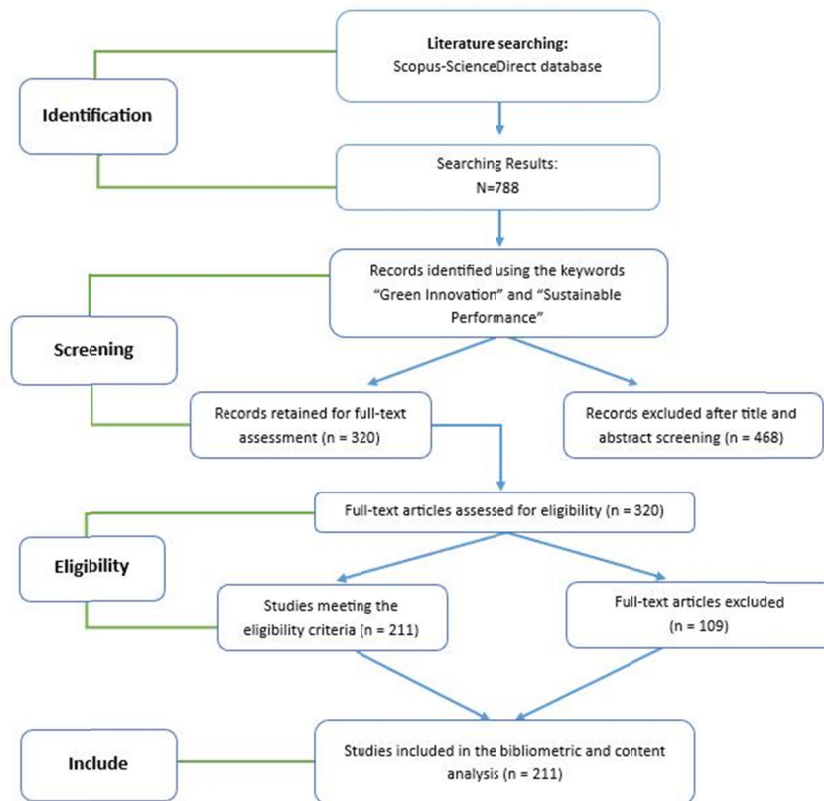


Fig. 1. PRISMA Flow Diagram of the Systematic Literature Review Process.

4. Results.

4.1. Descriptive Analysis.

Based on an analysis of 211 articles published from 2019 to 2025, green innovation has emerged as a relatively new but increasingly significant topic in the academic literature, particularly in relation to SP. The annual publication trend in Figure 2 is derived from a focused subset of 103 studies explicitly examining the GI–SP relationship.

The remaining articles were used for bibliometric clustering and thematic mapping. Figure 2 shows a gradual upward trend in publications in green innovation and SP. The years 2019 and 2020 can be categorised as the initial phase, with the volume of scholarly works remaining low, spanning from 5 to 8 articles per year. The study of GI and its linkages to SP remains a minor focus in the academic literature. Awareness of its integration with the digital economy and resilience is emerging. A significant increase was observed between 2021 and 2024, with the number of publications rising sharply from 14 articles in 2021 to a peak of 25 articles in 2024. This increase reflects the growing global recognition of green innovation as an enterprise strategy and a solution for mitigating the climate crisis.

It also addresses sustainability demands and facilitates the transition to a net-zero economy and the bioeconomy. This period was also influenced by external factors, such as the COVID-19 pandemic, which spurred research on resilient business models (Arsawan et al., 2024; Roman et al., 2023), resource efficiency, and the adoption of green innovation to enhance competitiveness (Le, 2022). This surge also indicates that green innovation is increasingly relevant in supporting the three pillars of sustainability (economic, societal, and environmental) with the integration of digital sustainability and green corporate governance.

Despite reaching a peak in 2024, a decline was observed in 2025 (11 publications), which should be interpreted with caution, as the figures reflect partial-year data rather than a complete publication cycle.

Overall, these trends underscore the shift of green innovation from a marginal issue to a mainstream theme in sustainability, management, and resilient economic studies. These data highlight the relevance of this research field and the significant opportunities for academic and public policy contributions, particularly in integrating circular and bioeconomies to build resilience (Figure 2).

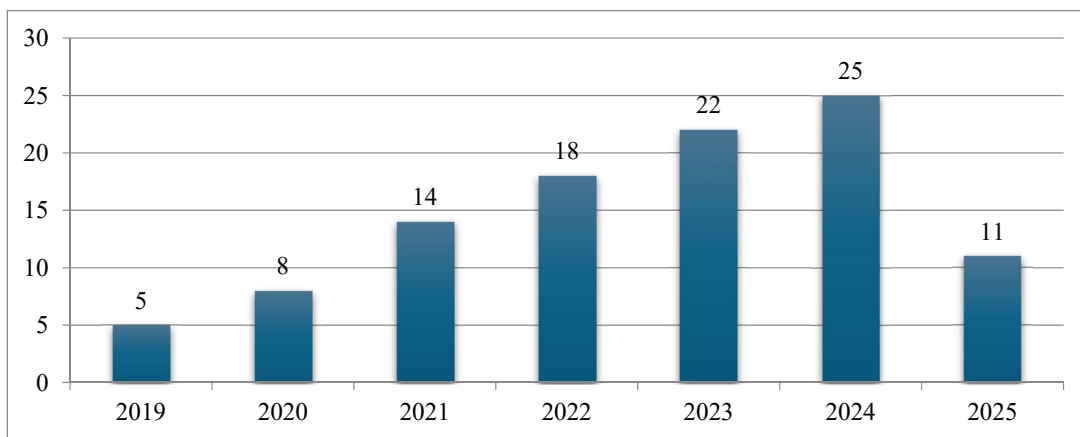


Fig. 2. Publication Trends on Green Innovation in Sustainability Studies (Per Year).

4.2. Bibliometric Analysis.

Based on bibliometric clustering, six notable clusters were identified in this systematic literature review (SLR) (Figure 3), highlighting potential areas for future research to improve publication quality and networks.

This clustering also considers integrating themes from the green, digital, and resilient economies, including green business, corporate governance, digital sustainability, a net-zero economy, a circular economy, and a bioeconomy, to enrich the analysis.

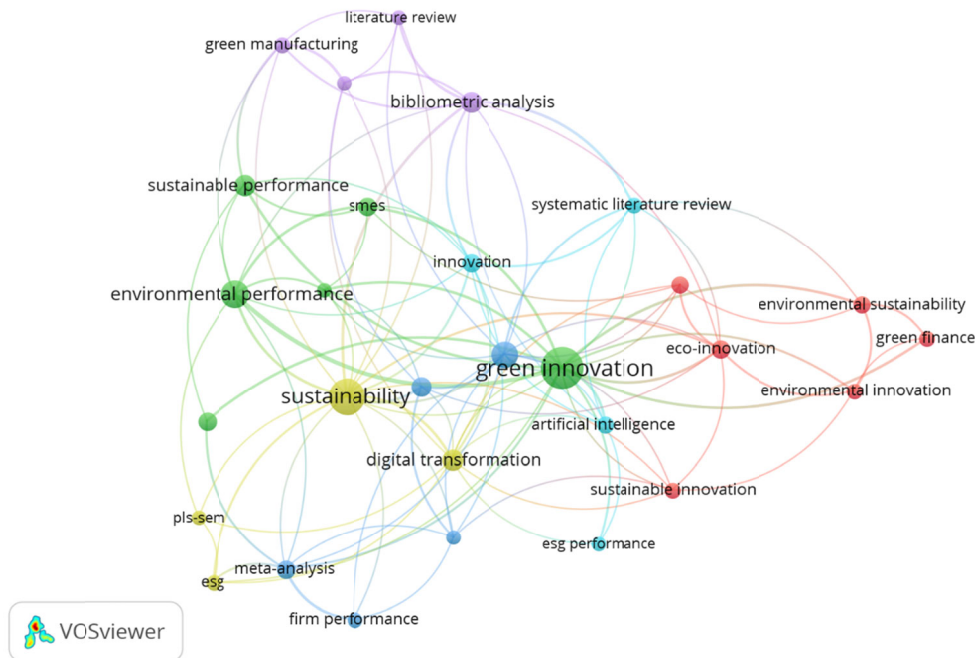


Fig. 3. Network Visualisation (VOSviewer).

4.2.1. Cluster 1. Eco-Environmental Innovation and Sustainable Finance.

This cluster emphasises the role of environmental innovation and green finance as key catalysts for achieving sustainability. The literature in this cluster discusses the linkages among environmental innovation, green policies, and sustainable finance instruments to accelerate the transition to greener business practices, including green corporate governance, which supports a net-zero economy and digital sustainability. The dominant in this cluster is environmental innovation as a key instrument for achieving sustainability.

Numerous studies have consistently emphasised that the successful implementation of environmentally friendly innovations reduces ecological impacts and increases company competitiveness by creating sustainable added value (Chen et al., 2024; Zhang, 2022). Research focuses on green finance, incorporating mechanisms such as green bonds, sustainable investments, and other green financing that serve as catalysts for advancing green innovation practices, particularly in industrial sectors under high environmental pressure (Bhutta et al., 2022; Omri et al., 2025).

Therefore, sustainable innovation in this cluster is primarily positioned as a strategic integration of economic, social, and ecological objectives. It emphasises that the transition to a green business model requires the support of a sustainable financial system and a strong orientation toward global development priorities, namely the Sustainable Development Goals (SDGs) (Alkaraan et al., 2023). This integration also supports the bioeconomy and resilient economy through sustainable financing.

4.2.2. Cluster 2. CSR and Green Supply Chains for Sustainable SME Performance.

This cluster focuses on integrating corporate social responsibility (CSR), green supply chain management (GSCM), and GI as important determinants for improving SP. Research in this cluster emphasises that CSR functions as an ethical responsibility and sustainability-oriented business strategy (C. Chen, 2024; Le et al., 2022). The green supply chain is a practical mechanism for realising CSR, directly impacting environmental performance and competitiveness (Ratnawati et al., 2024).

Furthermore, green innovation serves as a strategic link between CSR and green supply chain management, enabling the development of sustainable products, processes, and business models that create value aligned with the three pillars of sustainability (economic, social, and ecological).

This cluster emphasises that integrating CSR, green supply chain management, and GI is a complementary approach to driving business sustainability. In developing countries, integrating these three aspects makes a significant contribution to overcoming resource constraints, increasing market legitimacy, and strengthening resilience against compliance pressures and consumer expectations for green business practices (Le, 2022; Subramoniam et al., 2024). This approach aligns with green business and corporate governance, which supports the circular and bioeconomies for economic resilience.

In addition to these environmental and economic implications, this cluster highlights the role of corporate social responsibility and green supply chain management in safeguarding labour standards, enhancing employee welfare, and strengthening relationships with local communities and supply chain stakeholders (Bahta et al., 2021; El Jaouhari et al., 2025). These social outcomes contribute to organisational legitimacy and stakeholder trust, which are essential for sustaining long-term performance, particularly for SMEs operating under resource constraints and facing increasing social compliance pressures.

4.2.3. Cluster 3. Circular Economy and Sustainable Supply Chain Development.

This cluster highlights the circular economy as a new paradigm for strengthening corporate performance and promoting sustainable development. The literature emphasises that the implementation of circular economy principles, i.e., reduce, reuse, recycle, and remanufacture, has direct implications for increasing resource efficiency and reducing waste (Kumar et al., 2025; Saari et al., 2024).

Sustainable supply chains are a key focus, requiring companies to integrate circular business models to create shared value for stakeholders (Ratnawati et al., 2024; Saari et al., 2024).

Recent research, supported by meta-analysis and empirical approaches, demonstrates that the circular economy has dual potential: as an instrument for mitigating environmental impacts and as a driver of competitive advantage (Tahir et al., 2024). This cluster emphasises that implementing a circular economy is an operational initiative and a fundamental strategy that directly contributes to long-term sustainability, business resilience, and the transition to an inclusive green economy, including the integration of the bio- and net-zero economies to support digital economic resilience.

4.2.4. Cluster 4. ESG-Oriented Digital Transformation and Sustainability.

This cluster emphasises the strategic role of digital transformation as a crucial determinant in strengthening environmental, social, and governance (ESG) principles. The literature in this cluster primarily adopts quantitative approaches and emphasises the complex linkages among digitalisation (Le et al., 2024; Wang & Esperança, 2023), ESG, and sustainability performance (Alkaraan et al., 2025).

Several studies have shown that the use of digitised technology improves organisational efficiency and broadens transparency, accountability, and legitimacy of organisational governance (Le et al., 2024). Digitalisation is seen as capable of providing a more real-time monitoring system, strengthening sustainability reporting, and minimising opportunistic practices in corporate governance.

This cluster focuses on how digital transformation serves as a strategic foundation that enables companies to internalise ESG principles in core business processes. Thus, digital transformation is a critical and transformative force in shaping a company's long-term sustainability orientation.

The integration of digitalisation and ESG emphasises that sustainability is not merely an add-on but an integral part of corporate strategy, with direct implications for competitiveness, social legitimacy, and the achievement of sustainable development goals (Liu et al., 2025; Sadiq et al., 2023). This approach supports digital sustainability and a resilient economy by enabling corporate governance to adapt to environmental disruptions. Moreover, ESG-oriented digital transformation supports social sustainability by enhancing transparency, accountability, and stakeholder inclusiveness through data-driven monitoring and real-time sustainability reporting (Bolognesi et al., 2025).

4.2.5. Cluster 5. Green and Sustainable Manufacturing Research Landscape.

The studies in this cluster not only describe publication developments but also present conceptual maps that show interlinkages between topics, author collaboration patterns, and identify remaining research gaps. The analysed literature demonstrates that green manufacturing innovation is fundamental in driving energy productivity, reducing carbon emissions, and enhancing industrial performance in a sustainable context (Di Foggia, 2021; Tabares et al., 2025).

Research in this cluster also highlights that the transformation towards green manufacturing requires the incorporation of sustainable technologies, the application of eco-design principles, and the integration of circular economy principles into production processes (Chaudhuri et al., 2023; Dolci et al., 2024). It is relevant to responding to environmental regulatory and policy demands and serves as a long-term strategy to strengthen corporate legitimacy in the eyes of stakeholders. Javed et al. (2025) and Yadegaridehkordi et al. (2023) emphasised that the success of sustainable manufacturing is greatly influenced by an organisation's capability to manage innovation, build cross-sector partnerships, and develop green financing mechanisms that support sustainable production processes.

Thus, this cluster makes a significant contribution to providing a theoretical foundation and a roadmap for future research in sustainable manufacturing.

Consequently, the research findings in this cluster have the potential to serve as an important reference not only for theory development but also for industry practitioners and policymakers in designing more effective, adaptive, and long-term sustainability-oriented green manufacturing strategies. This includes the integration of the bioeconomy and the net-zero economy to support resilient green business.

4.2.6. Cluster 6. AI-Based Innovation and ESG Performance.

This cluster highlights the embedding of artificial intelligence (AI) as a key enabler of strengthening innovation and boosting environmental, social, and governance (ESG) performance. The literature emphasises that AI use extends beyond business process automation to serve as a strategic tool that enables organisations to optimise data-driven decision-making within a sustainability framework (Kumar et al., 2025; Liu et al., 2025).

Furthermore, AI contributes significantly to operational efficiency, transparency, and accountability (Bahoo et al., 2023). The integration of AI with sustainable innovation opens new opportunities for interdisciplinary research, particularly at the intersection of technology, management, and public policy. Several studies underscore the importance of organisational readiness in digital capabilities, data governance, and the ethical use of AI, not only to improve business efficiency but also to support social justice and environmental sustainability (Bolognesi et al., 2025; Sahibzada et al., 2025).

Thus, this cluster represents a new direction of research that emphasises the urgency of integrating innovation with ESG principles while simultaneously strengthening organisational competitiveness in a global business ecosystem increasingly oriented towards sustainability, including digital sustainability and a resilient economy, through adaptive corporate governance.

Therefore, it is important to emphasise the role of AI in making effective decisions for sustainable business development, which is crucial for organisational development. By applying automated learning systems, predictive analytics, and language processing, AI can identify patterns, predict risks, and provide strategic recommendations that support the accurate and measurable implementation of ESG principles.

The overlay visualisation results show that the most researched topics in 2022 were green manufacturing, bibliometric analysis, environmental performance, and eco-innovation. In 2023, research shifted to sustainability, sustainable innovation, firm performance and meta-analysis.

From 2024 to 2025, topics such as green innovation, environmental sustainability, digital transformation, artificial intelligence, ESG performance, green finance and environmental issues became dominant. This temporal pattern is visualised using the average publication year metric.

Darker blue tones represent earlier research (2022), whereas lighter green to yellow tones indicate recent and emerging themes (2024–2025). Darker nodes indicate mature streams, whereas lighter yellow-toned nodes represent emerging and rapidly developing topics, such as digital transformation, artificial intelligence, ESG performance, and green finance. The 2025 data are partial (up to October 2025), and the most recent trends should be interpreted with caution.

Furthermore, green innovation is the foundation for driving sustainability (Aftab et al., 2022; Rahmani et al., 2024; Wang & Esperança, 2023). An overview of the research topic is presented in Figure 4. Figure 5 shows that GI has emerged as an intensively researched topic, followed by sustainability, environmental performance and SP. Less-researched topics include sustainable innovation, environmental innovation, green manufacturing, ESG performance, digital transformation, and AI, all of which offer significant opportunities for future research.

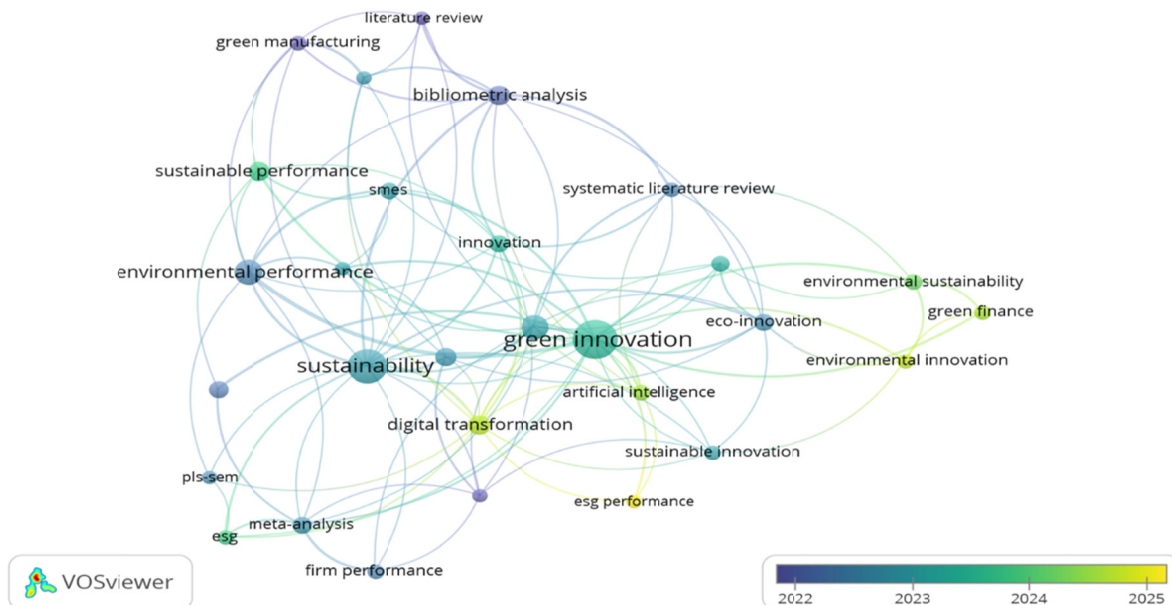


Fig. 4. Overlay Visualisation (VOSviewer).



Fig. 5. Density Visualisation (VOSviewer).

Bibliometric mapping revealed six main thematic clusters, which were synthesised into an integrated framework. This framework shows how internal capabilities, technological advancements, entrepreneurial strategies, and stakeholder engagement collectively drive GI and its link to sustainable competitive advantage (Agyabeng-Mensah & Tang, 2021; Alkaraan et al., 2025; Dahri et al., 2025). Underlying the framework is the intersection of GI and SP, which serves as a conceptual anchor for the interaction of all clusters.

This structure reflects a dynamic, multilevel model that highlights the interdependence of digital transformation, innovation strategy, organisational resources, and the external ecosystem within the context of a green, digital, and resilient economy (Huang et al., 2025; Kwilinski et al., 2025). The proposed conceptual framework (Figure 6) provides a structured synthesis of the linkages between six key clusters of green innovation and their effect on sustainable business performance. Consistent with the Triple Bottom Line framework, the proposed framework integrates social sustainability through CSR practices, stakeholder engagement, labour-

related supply chain considerations, and ethical governance mechanisms, which collectively reinforce organisational legitimacy and long-term resilience alongside environmental and economic performance (Cavalieri et al., 2024).

Based on a systematic analysis of 211 scientific articles published between 2019 and 2025, this study develops an integrative conceptual model that combines internal and external organisational factors, stakeholder engagement, and strategic and digital dimensions within a coherent analytical framework. Rather than treating these dimensions as isolated drivers, the model emphasises their interdependent roles in shaping green innovation and sustainable business performance.

Each directional linkage in the model represents not only a pathway of influence but also a thematic interconnection that reflects the co-evolution of concepts within the literature. These relational linkages form the basis for a contextual interpretation of the six main clusters, which synergistically underpin the conceptual, operational, and strategic foundations of effective green innovation implementation.

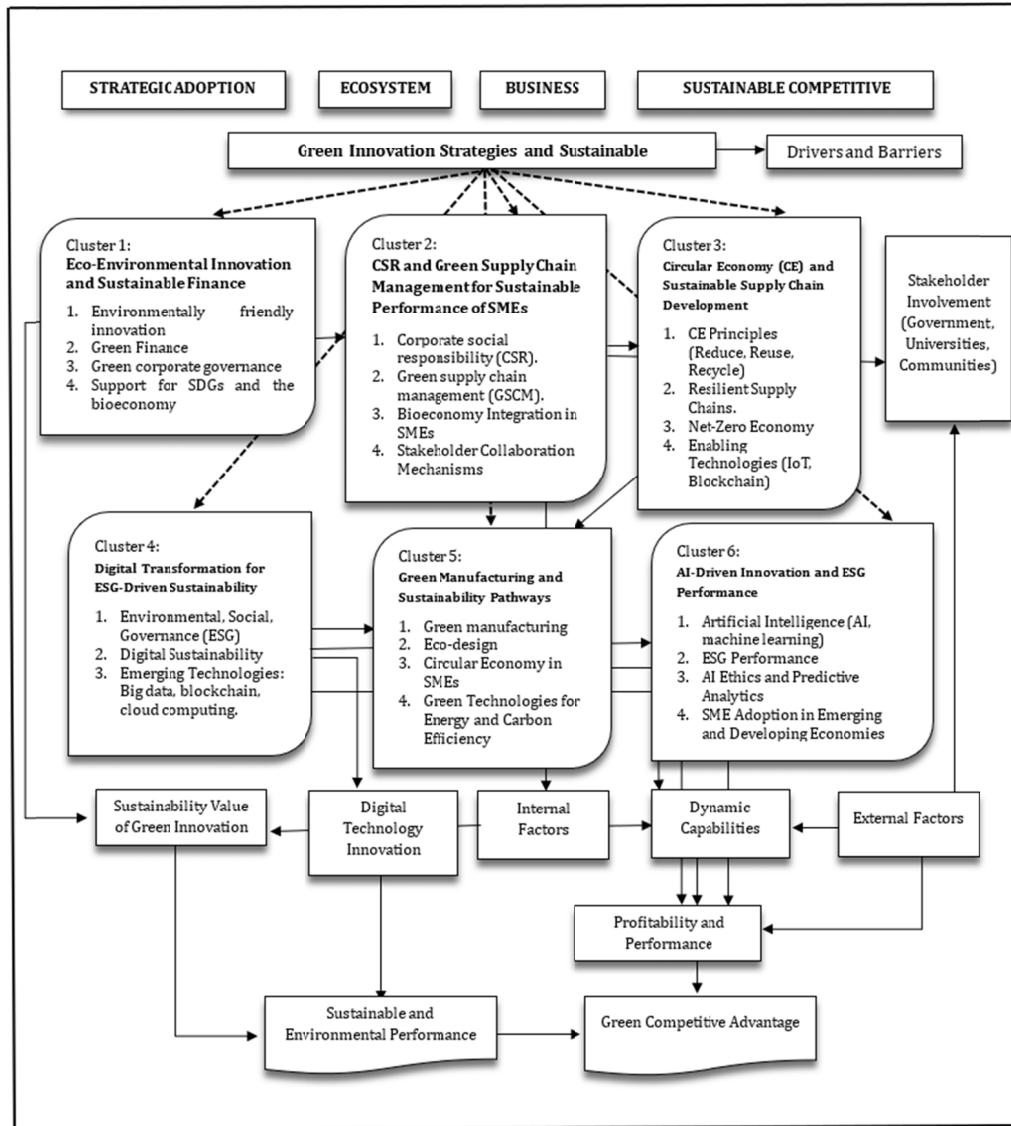


Fig. 6. Mapping of Green Innovation Clusters and Their Implications for Business Performance.

Consistent with RQ1, co-word analysis and thematic evolution mapping reveal a significant temporal shift in the thematic structure of green innovation research related to sustainable performance over the past decade.

The findings indicate an evolution from fragmented, practice-oriented themes in the earlier period to a more integrated and systemic conceptualisation of sustainability in recent years. The six identified clusters form a transformation chain in which financial mechanisms, operational practices, production paradigms, and digital technologies increasingly interact in nonlinear and interconnected ways.

This thematic evolution reflects a paradigmatic transition from viewing sustainability as the cumulative outcome of discrete innovation activities to understanding it as the emergent result of aligned configurations of resources, technologies, and institutional conditions (Rahmani et al., 2024).

Regarding RQ2, the citation and co-citation network analyses reveal that the green innovation–sustainable performance literature is based on knowledge clusters. These clusters are primarily structured around sustainable finance, green supply chain management, circular economy, and digital transformation.

Highly cited and seminal publications within these clusters serve as key intellectual anchors, providing a theoretical and empirical basis for understanding how innovation activities are translated into sustainability performance outcomes.

Importantly, the co-citation patterns indicate that these influential studies increasingly act as conceptual bridges across clusters, reflecting a converging knowledge base, rather than isolated thematic streams. (Dolci et al., 2024; L. Li et al., 2022; Xu et al., 2025). Scholarly influence in this field thus appears increasingly contingent on the ability to explicate cross-cluster mechanisms rather than merely identifying individual antecedents of performance.

Addressing RQ3, the bibliometric clustering, overlay visualisation, and collaboration network analysis reveal several structural gaps and underexplored research avenues within the existing literature. The interconnections among the six clusters suggest a pathway of influence flowing from digital technology innovation to internal organisational factors, particularly through the development of dynamic capabilities (Kluza et al., 2021, Liu et al., 2025).

However, overlay analysis indicates that these relationships remain insufficiently integrated across research streams. External factors, such as green financing and policy support, are frequently examined in isolation, and their effects on sustainability performance appear to be primarily indirect and contingent on firms' internal capacities (Li, 2025; Zheng et al., 2025).

Moreover, although green supply chain management provides a critical operational foundation, collaboration network patterns suggest limited integration with circular economy logic and digitally enabled coordination mechanisms.

These gaps highlight the need for future research to adopt integrative, cross-cluster, and longitudinal approaches that explicitly examine how internal capabilities, external institutional conditions, and digital infrastructure jointly shape sustainable performance outcomes (Carballo-Penela et al., 2023).

Based on this structural interpretation, green supply chain management (GSCM) can be more clearly positioned as a core implementation mechanism through which green innovation is operationalised into sustainable performance outcomes.

Dynamic capabilities enable firms to adapt and reconfigure supply chain routines in response to sustainability demands (Alyasein et al., 2025), and digital transformation enhances coordination, transparency, and data-driven decision-making across supply chain networks (Leutheuser, 2025). A circular economy orientation provides the strategic logic that elevates GSCM beyond incremental efficiency improvements toward closed-loop value creation, whereas governance alignment, particularly through ESG-oriented policies and stakeholder engagement, legitimises and stabilises these transformations (Kluza et al., 2021; Le et al., 2022).

In the absence of such alignment, GSCM initiatives risk remaining fragmented or symbolic, offering limited contributions to sustainable performance. Digital transformation emerges as a pivotal, yet ambivalent, connective node within the model. The digitalisation and artificial intelligence cluster enhances data-driven decision-making, improves transparency, and enables coordination among actors within complex value systems. However, the literature also cautions that digitalisation may reinforce short-term efficiency logic if it is not explicitly oriented toward circularity and long-term sustainability objectives.

This tension underscores that digital technologies are not neutral drivers of sustainability but are shaped by the strategic orientation and governance frameworks within which they are embedded. The synergy among the six clusters demonstrates that effective GI implementation does not stem from the dominance of any single dimension but rather from the functional alignment of sustainable finance, operational capabilities, circular economy orientation, and purposefully directed digital transformation. In contrast to previous studies (Cheah et al., 2024; Chopra et al., 2021; Huang et al., 2025), this study combines a SLR with bibliometric analysis.

This integrated methodology provides a comprehensive response to all three research questions, advancing the literature by offering a relational perspective on the evolution of green innovation (GI) research. Specifically, it identifies the core intellectual foundations of the field.

It also pinpoints critical areas for future exploration, particularly in the context of developing countries and through longitudinal research designs. Finally, the future research agenda should focus on localised and longitudinal studies to evaluate the impact of green innovation (Table 1).

Table 1. Clustered Future Research Directions in Green Innovation.

No	Cluster	Future Directions
1	Eco-Environmental Innovation and Sustainable Finance	1. Developing a cross-country empirical model to measure the linkage between green finance (green bonds, sustainable investment) and eco-innovation adoption. 2. Examining the role of the bioeconomy and digital economy as mediators between environmental innovation and the SDGs. 3. A qualitative approach to explore green financing practices and develop an integrative model that combines innovation strategy, knowledge management, and organisational performance based on green corporate governance.
2	CSR and Green Supply Chain for Sustainable Performance	1. Exploring the differences in the impact of CSR–GSCM integration in various sectors (manufacturing, agribusiness, tourism). 2. Examining cross-stakeholder collaboration mechanisms in strengthening the legitimacy of green CSR. 3. Examining the role of digital CSR as a bridge between supply chain transparency and sustainability.
3	Circular Economy and Sustainable Supply Chain Development	1. Examining the challenges of circular economy adoption with regulatory and resource constraints. 2. Developing indicators of success in implementing a circular economy through longitudinal studies and panel data. 3. Exploring the role of technology (IoT, blockchain) in strengthening the circular supply chain.
4	ESG-Oriented Digital Transformation and Sustainability	1. Examining the linkage between digital transformation, ESG, and SP with a longitudinal approach. 2. Scrutinising the contribution role of digitised capabilities in internalising ESG principles. 3. Examining the contribution of big data, blockchain, and cloud computing to sustainability transparency and accountability.
5	Green and Sustainable Manufacturing Research Landscape	1. Connecting eco-design, digital manufacturing, and the circular economy. 2. Field studies to test the effect of green technology adoption on power conservation and carbon emissions. 3. Developing an integrative framework that links regulatory, financial, and organisational capability aspects in sustainable manufacturing.
6	AI-Based Innovation and ESG Performance	1. Exploring the use of AI in developing countries with limited infrastructure. 2. Developing an AI-based predictive framework to monitor and improve ESG performance.

5. Conclusions.

This research yields three primary insights. First, the mapping of green innovation and SP revealed six key research clusters, demonstrating that green innovation is not only an environmental instrument but also a strategic foundation for strengthening competitiveness and legitimacy in the conversion to a green economy.

Second, green innovation is a relevant topic, especially amid resource constraints, regulatory pressures, and consumer demands for sustainable business practices. These findings underscore the need for organisations to prepare resources, capabilities, and cross-sector collaboration strategies to adopt green practices aligned with global agendas, such as the SDGs, the bioeconomy, and the net-zero economy.

Third, research developments indicate a shift from describing green innovation to exploring how internal capabilities, including dynamic capabilities, digital capabilities, and organisational governance, mediate the linkage between GI and SP. Digital transformation, circular economy integration, and AI have emerged as key catalysts in shaping a modern GI ecosystem. The contribution of green supply chain management to sustainable performance depends on its integration into broader dynamic capabilities and governance-aligned innovation systems. Publication patterns observed for 2025 are based on partial-year data coverage (up to October 2025) and should therefore be interpreted with caution when assessing recent trends or apparent declines in trends.

Bibliometric evidence indicates that green innovation is positioned as a dynamic organisational capability integrated with digital transformation, governance structures, and supply chain systems. This thematic pattern conceptualises sustainable performance as requiring alignment of internal capabilities, cross-functional integration, and digitally enabled coordination mechanisms. Research trends highlight the importance of coherent regulatory frameworks, targeted financing, and digital infrastructure in supporting the diffusion of green innovation across sectors. Recent literature emphasises integrated policy approaches that link green finance, circular economy practices, and digital sustainability as part of the transition toward resilient, low-carbon economic systems.

This review identifies a critical research gap concerning the social dimension of green innovation. The literature has predominantly emphasised environmental and economic outcomes, leaving social sustainability dimensions, such as well-being, inclusion, and societal impact, under-theorised and under-examined empirically. Integrating social performance into green innovation research is essential to advancing a more comprehensive sustainability perspective. Future research should refine social sustainability indicators and employ longitudinal designs better to capture the evolving social consequences of green innovation strategies, thereby strengthening both theoretical coherence and policy relevance.

Considering these gaps, future research may advance understanding across the six thematic clusters. For eco-environmental innovation and sustainable finance, studies could develop cross-country empirical models linking green finance and eco-innovation, examine the mediating role of the bioeconomy and digital economy, and investigate integrative models combining innovation strategy, knowledge management, and organisational performance. CSR and green supply chain research can examine sectoral differences in CSR–GSCM integration, cross-stakeholder collaboration mechanisms, and digital CSR as a bridge between transparency and sustainability. Circular economy studies may address adoption challenges, develop longitudinal indicators of success, and explore technology-enabled supply chains.

ESG-oriented digital transformation research should investigate longitudinal linkages with SP, the role of digitised capabilities, and contributions of big data, blockchain, and cloud systems. Green and sustainable manufacturing studies could connect eco-design, digital manufacturing, and circular economy principles, assess their impacts on energy and emissions, and develop integrative regulatory, financial, and organisational frameworks. AI-based innovation research should explore AI adoption in emerging contexts and develop predictive frameworks for ESG performance.

Overall, future research should adopt a contextual, longitudinal approach to capture the dynamics of green innovation adoption while considering internal organisational capabilities, external policy support, stakeholder engagement, and digital technological enablers. This strategy will strengthen both theoretical understanding and practical guidance for sustainable business transformation.

Conflict of Interest Statement.

The authors declare that there is no conflict of interest.

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