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Integrating Sustainable Practices in Indian Manufacturing Small Medium Enterprises: A BASLR Approach

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Abstract

This study examines sustainable practices in manufacturing Small and Medium Enterprises (SMEs), with particular attention to the challenges, drivers, and strategies that influence sustainable performance. A dual-method approach, combining Bibliometric Analysis and Systematic Literature Review (BASLR), provides a robust analytical foundation for understanding the current state of sustainable innovation in SMEs. The findings highlight key barriers, including limited eco-innovation, inadequate infrastructure, and sluggish digital transformation. Overcome these obstacles, the study underscores the importance of adopting sustainable practices such as promoting high-quality innovation, fostering entrepreneurial competencies, advancing digital transformation, and developing green capabilities. Based on these insights, a conceptual model is proposed to guide Indian SMEs in achieving sustainable performance across environmental, economic, and social dimensions through sustainable innovation practices.

Introduction

Small and Medium Enterprises (SMEs) are the backbone of India's economy, contributing approximately 30% to the national GDP and employing over 110 million people (Ministry of MSME, 2023). In manufacturing, SMEs are crucial for boosting industrial output, exports, and job creation. Despite their economic importance, Indian manufacturing SMEs face considerable challenges that hinder their growth, competitiveness, and capacity to implement sustainable practices. The primary challenges include limited access to financing, reliance on outdated technology, and a shortage of skilled labour (FICCI, 2020). Moreover, as global markets shift towards eco-friendly and sustainable practices, Indian SMEs face growing pressure to align with these standards to remain competitive (Nasiri et al., 2022; Sangwan and Choudhary, 2018).

Unlike larger firms, SMEs often struggle to secure credit due to a lack of collateral and financial resources, restricting their ability to invest in necessary technology upgrades and sustainability initiatives (IFC, 2021). Global environmental challenges such as climate change have led to increased stakeholders' pressure on firms to mitigate the impact of their activities on the natural environment (Adomako, 2020). Additionally, a shortage of skilled workers in areas such as sustainable manufacturing and digital technology limits the productivity and innovative potential of Indian SMEs (NSDC, 2020). This skills gap is

particularly concerning as international competitors increasingly adopt advanced, eco-friendly technologies, putting Indian SMEs at a disadvantage (Agasty et al., 2023).

Sustainable innovation in SMEs plays a pivotal role in achieving both profitability and social performance (Adomako, 2020). Given the scale of environmental and social challenges the world faces today, enterprises regardless of size should prioritize the development of sustainable and innovative solutions that balance economic, environmental, and social viability (Dasgupta, 2023). Financial, technical, and operational challenges collectively create a technology gap, hindering Indian SMEs from fully adopting sustainable innovations (FICCI, 2020; Sangwan and Choudhary, 2018).

Due to energy crises, deforestation, and global warming, sustainability is becoming increasingly important for innovative research and practice (Morales et al., 2022). Benchmarking global best practices offers Indian SMEs a valuable opportunity to implement sustainable practices. Manufacturing firms have a responsibility to prioritize sustainable development by incorporating sustainable product innovation practices to maintain competitive advantage. Sustainable innovation practices reduce environmental impact, enhance operational efficiency, and strengthen brand reputation, while simultaneously achieving profits and social performance to meet the expectations of global consumers and regulators for SMEs (Adomako, 2020).

However, challenges specific to Indian SMEs, such as high implementation costs and limited awareness of eco-friendly alternatives, continue to hinder the adoption of sustainable practices. Nevertheless, sustainable innovation practices remain a crucial pathway for Indian SMEs to achieve long-term growth and address rising consumer demands for environmentally responsible products. In response to these challenges and opportunities, this study is guided by the following research questions:

1. What key barriers limit sustainable innovation adoption in Indian manufacturing SMEs?
2. How can Indian SMEs adopt sustainability practices to overcome barriers and align with global practices?
3. What strategies foster sustainable innovation and improve sustainable performance in Indian manufacturing SMEs?

The objective of addressing these research questions is to identify barriers to sustainable innovation in Indian SMEs. The study aims to explore global practices and propose strategies that enhance sustainability and performance by leveraging internal and external support. To achieve these objectives, this research employs the Bibliometric Analysis and Systematic Literature Review (BASLR) approach, integrating Bibliometric Analysis with a Systematic Literature Review. The BASLR Approach ensures a robust foundation for understanding the current landscape of sustainable innovation in SMEs, identifying key barriers, and uncovering global best practices. By leveraging this combined approach, the study can propose actionable strategies tailored to Indian manufacturing SMEs to address unique challenges and opportunities for sustainable growth.

Methodology

The dual-method approach (BASLR Approach) provides a comprehensive and robust analysis of sustainable innovation within manufacturing SMEs. Bibliometric Analysis offers a quantitative perspective by mapping the literature, identifying key themes, influential studies, and publication trends, thus capturing the breadth of research in the field. Meanwhile, a Systematic Literature Review delivers a qualitative synthesis, insights from prior studies, and uncovering research gaps. By combining these methods, the study ensures a balanced exploration of both the scope and intricacies of sustainable innovation practices, enabling a nuanced understanding that integrates broad trends with detailed insights. This dual approach enhances the reliability and richness of the findings, supporting actionable strategies for Indian SMEs.

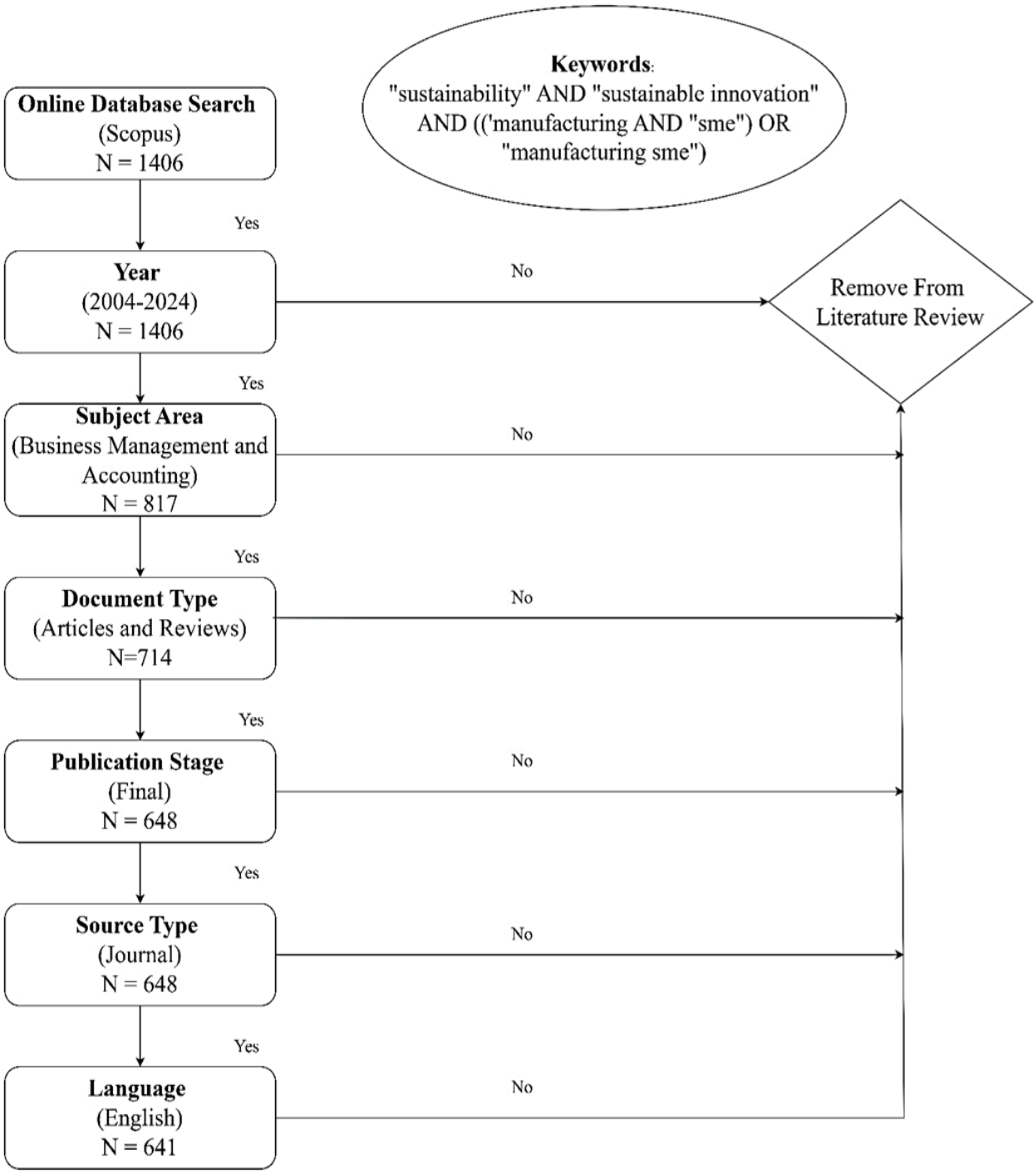
Bibliometric Analysis

The bibliometric analysis quantitatively examines the literature on sustainable innovation within manufacturing SMEs, revealing publication trends, thematic concentrations, and key contributors in the field. ‘Scopus’ was selected as the primary database due to its extensive coverage of SME and sustainability research. A search was conducted using Boolean operators and targeted keywords, “sustainability,” “sustainable innovation,” “manufacturing,” “SME,” and “manufacturing SME”, yielding an initial set of 1,406 documents published between 2006 and 2024.

To refine the dataset, specific inclusion criteria were applied, restricting the selection to articles and reviews published in English within the domains of business, management, and accounting. Non-English publications, unpublished works, and studies unrelated to sustainable practices were excluded, reducing the selection to 641 documents. The resulting dataset was analyzed using “Biblioshiny”, an R-based web application for bibliometric analysis. “Biblioshiny” facilitated a structured examination of keywords, author networks, and thematic clusters, allowing for a nuanced understanding of the field’s intellectual structure and emergent research trends.

This bibliometric approach provided insights into research patterns, key contributors, and under-explored areas relevant to sustainable innovation in SMEs. The entire process is illustrated in Figure 1, which visually represents each stage of the search and refinement process, highlighting the systematic approach taken to filter and analyze the literature. Building on the trends identified in the bibliometric analysis, we conducted a systematic literature review to gain deeper insights into the sustainable practices that Indian manufacturing SMEs can adopt to enhance their sustainable performance.

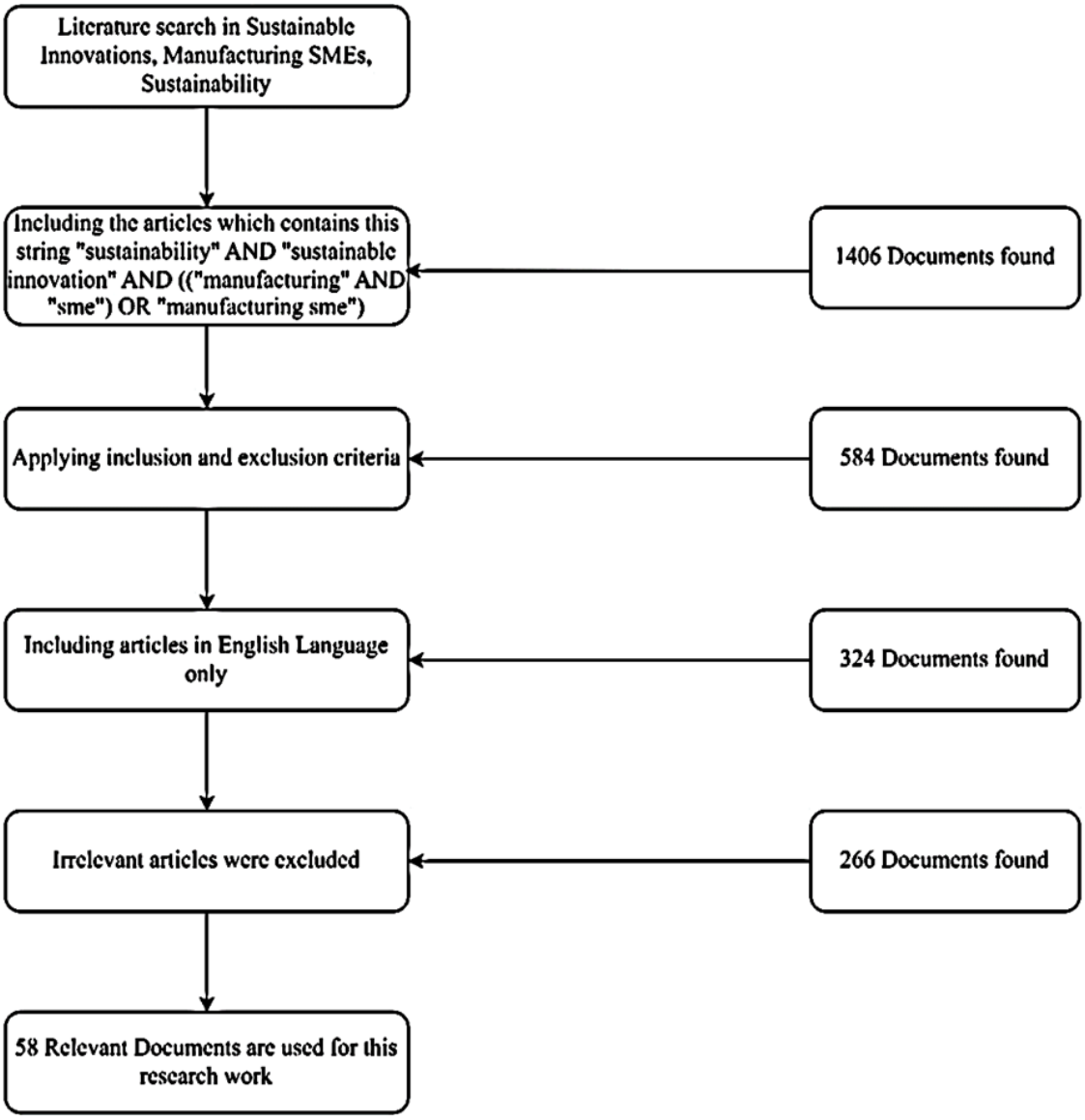
Figure 1
Bibliometric Analysis Flowchart



Systematic Literature Review

Following the bibliometric analysis, a Systematic Literature Review (SLR) was conducted to gain deeper qualitative insights into sustainable innovation practices within manufacturing SMEs (see Figure 2). The SLR methodology follows the guidelines proposed by Tranfield et al., (2003), emphasizing rigor, transparency, and replicability in the selection and synthesis of literature.

Figure 2
Systematic Literature Review Flowchart



Building on the refined set of 641 documents from the bibliometric analysis, additional filtering was applied to align the dataset more closely with the study's objectives. Firstly, the inclusion and exclusion criteria were reapplied, reducing the dataset to 584 articles. Subsequently, the search was limited to English-language studies, narrowing the selection further to 324 documents. A final manual screening excluded studies that did not directly address sustainable innovation in SMEs, resulting in a final set of 58 articles. Figure 2, summarizes each stage of the screening process, underscoring the methodological rigor in selecting high-quality, relevant literature.

Integration of Bibliometric and SLR Insights

Integrating bibliometric analysis and SLR provided a balanced and comprehensive understanding of sustainable innovation within SMEs. The bibliometric analysis offered quantitative insights into research networks, themes, and trends, establishing a broad

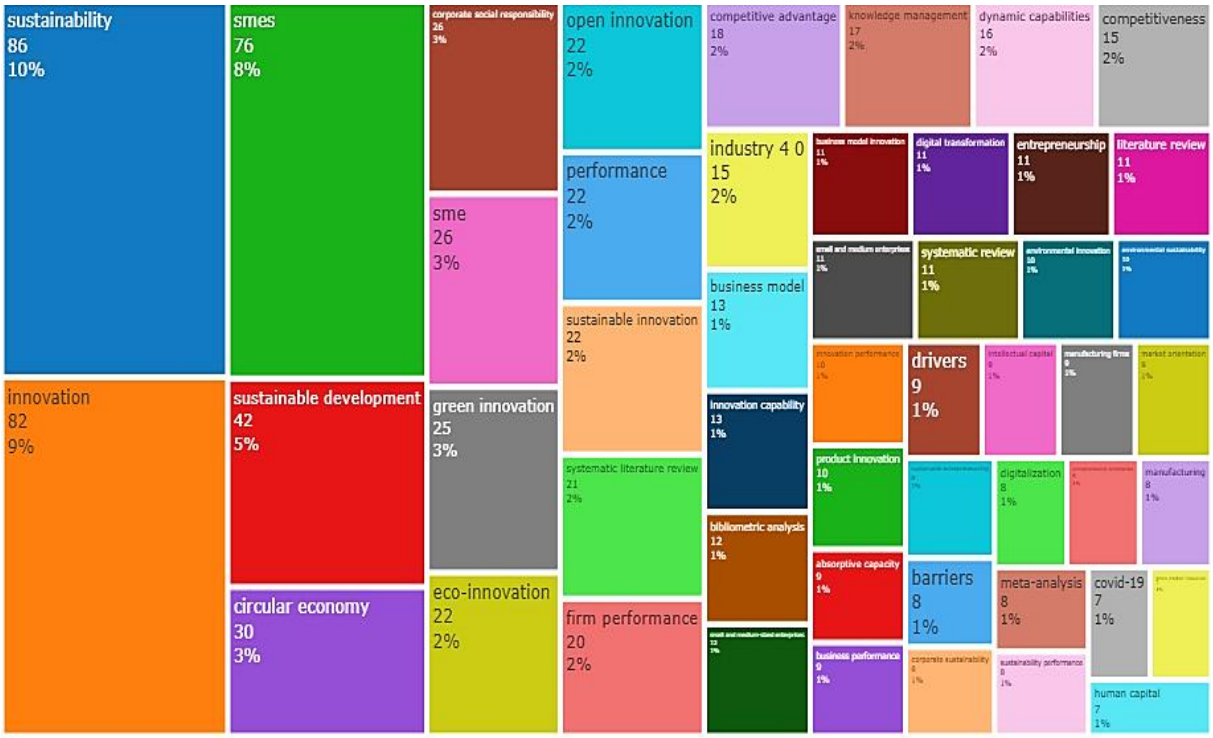
literature overview. In contrast, the SLR facilitated a more granular, qualitative assessment of the studies' specific contributions, enabling a nuanced understanding of the factors driving sustainable practices within SMEs. This combined approach ensured a robust foundation for analyzing sustainable innovation, addressing both the breadth and depth of literature on this topic.

The most important keywords from Bibliometric Analysis

A visual representation of the topmost used keywords identified as most important from this study via tree map analysis is shown in Figure 3. The term "sustainability" is the most mentioned, occurring 86 times, indicating a strong focus on sustainability practices in small and medium-sized firms in the available literature. The term "innovation" appears 82 times, making it the second most used keyword.

This highlights the increasing significance of innovative sustainable practices in research. The term "smes", "sustainable development", "circular economy", "corporate social responsibility", "eco-innovation", "green innovation", "sustainable innovation", "open innovation", "performance", "firm performance" etc, is shown to be most important, suggesting a significant emphasis on creative methods, especially those about environmental and sustainability matters. These commonly utilized keywords provide a concise overview of the main subjects influencing the current research trends among the authors.

Figure 3
Tree Map of Important Keyword



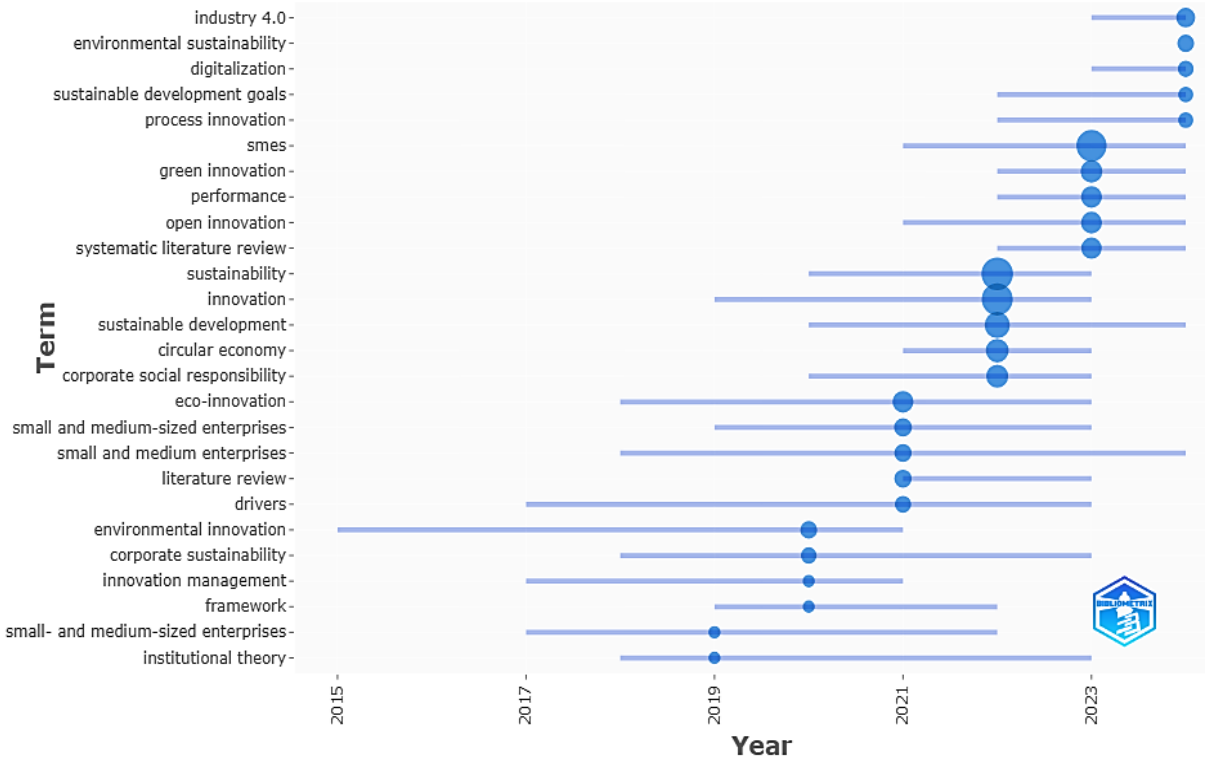
The tree map of important keywords in Figure 3 presents a distinctive advantage by delivering a clear and concise visualization of the research landscape, which is especially useful for pinpointing niche areas and underexplored topics in sustainable innovation.

Also, the tree map presents data in a unique manner, thereby enhancing the capacity to develop research directions and prioritize areas that align with emerging trends and gaps in the literature. This method facilitates academic inquiry and assists practitioners in aligning their efforts with the most significant and innovative fields of research.

Trend Topic Analysis

In recent years, there has been an increase in the use of phrases such as "Industry 4.0," "environmental sustainability," and "process innovation," especially after 2022. These phrases are linked to the increasing emphasis on sustainable innovation within SMEs. Figure 4 emphasizes the growing significance of "digitalization", "performance" and "open innovation" as crucial study fields, demonstrating a move towards incorporating environmental and performance-based elements into SME operations. The visualization of trend topic analysis from Figure 4 depicts the evolving topics in scholarly research over a period, with terms becoming increasingly prominent from 2015 to 2024. This trend highlights the growing scholarly and practical concern with sustainability and innovation and how these affect performance evaluations.

Figure 4
Trend Topic



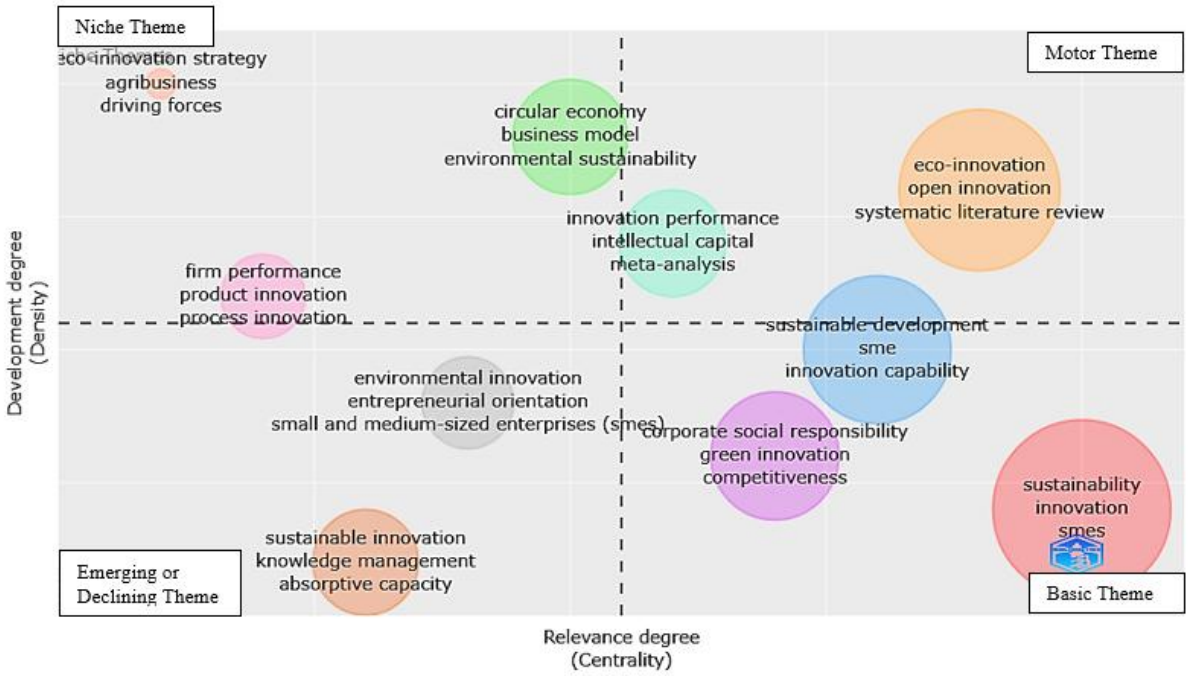
Thematic Map Analysis

An analysis of thematic maps was performed to discover developing themes within the domain. This research involved using 250-author keywords and setting a minimum cluster frequency of 5 per thousand articles. As a result, ten clusters were identified. Larger circles indicate more keywords in a cluster (Cobo et al., 2011). The map's dimensions are centrality and density. Centrality measures "the intensity of its links with other clusters", indicating a theme's significance in domain development. Density measures "the strength

of the links that bind the words within the cluster together", assessing the theme's capacity to adapt over time (Callon et al., 1983).

The second biggest cluster includes keywords such as "eco-innovation" and "open innovation", a "motor theme" with high density and centrality, indicating strong connections within the domain and its cluster. “Environmental innovation”, "entrepreneurial orientation”, "sustainable innovation", "knowledge management”, and "absorptive capacity” are minimally formed themes with low density and centrality, indicating their relevance but also implying they need to be more scholarly (Cobo et al., 2011).

Figure 5
Thematic Map



In the current scenario, “eco-innovation” and “open innovation” are the most trending topics, while themes such as “sustainable innovation” and “knowledge management” have greater potential and need further exploration, particularly in SMEs within the primary and secondary sectors, as shown in Figure 5.

Literature review

The increasing focus on sustainable development has placed sustainable innovation practices at the centre of research and practice, especially for SMEs. For Indian manufacturing SMEs, tackling sustainability challenges is imperative, as these enterprises play a critical role in economic growth while facing several challenges. This section examines the issues/barriers, key insights, and strategies for sustainable practices in SMEs. Based on the SLR sustainable practices followed in SMEs from 2007 to 2024 are listed in Table 1.

Table 1

Systematic Review of Sustainable Innovation in Manufacturing SMEs

Sl.No	Author (s) & Year	Identified Barriers/Issues	Major contribution of the study	Opportunities/Strategies
1	Chen and Wang (2024)	Lack of adoption of digital technologies by SMEs	Digital transformation is linked to ESG performance with innovation capabilities	SMEs should focus on digital strategy, adoption of technologies, and innovation
2	Fawad Sharif et al., (2024)	Resource constraints and lack of dynamic capabilities	Knowledge coupling, ambidexterity, and market capitalizing agility improve innovation performance	SMEs can combine internal knowledge with external resources to boost agility to drive innovation in crises.
3	Al-Swidi et al., (2024)	Limited resources and lack of digital transformation	CSR, combined with digital transformation, enhances green innovation in SMEs	Integrating CSR with digital transformation can boost SMEs' green innovation
4	Gomes et al., (2024)	Financial constraints, lack of knowledge, and market unpredictability in adopting sustainable practices.	Environmentally sustainable practices in SMEs drive green product/service, process, and organizational innovations.	Adopting sustainable practices can promote green innovation in SMEs.
5	Lin et al., (2024)	Lack of knowledge sharing, social innovation, and green volunteerism	Social and environmental innovation, knowledge-sharing culture (KSC), and green volunteerism enhance SMEs' entrepreneurial success	SMEs should foster KSC and integrate social/environmental innovations to boost competitiveness.
6	Adomako and Tran (2024)	Lack of investments in environmental R&D	Intra-and extra-industry stakeholder ties affect eco-innovation and new product performance.	Firms should strengthen ties with industry stakeholders and increase R&D spending to drive eco-innovation and enhance new product performance.
7	Guimarães et al., (2024)	SME does not have metrics to measure and monitor sustainable innovation	The study provided tools and key dimensions for assessing sustainable innovation, focusing on social and governance aspects.	SMEs should adopt tools for measuring sustainable innovation, focusing on social and governance dimensions.
8	Koliby et al., (2024)	Lack of entrepreneurial competence	Entrepreneurial competencies promote innovation and the sustainable performance of manufacturing SMEs	Innovate quickly to respond to change in market demands
9	Taghizadeh et al., (2023)	Pressure from multiple stakeholders to adopt a sustainability-focused approach	sustainable innovation performance of SMEs is influenced by the synergy of learning, integrating, and coordinating capabilities in a turbulent environment	SMEs shall demonstrate that learning, integrating, and coordinating capabilities are essential for firm's human, organizational, and social well-being.
10	Mady et al. (2023)	Struggle to align internal capabilities with environmental requirements	Internal environmental capabilities impact competitive advantage through eco-innovation in SMEs.	SMEs can enhance their green capabilities and strategic orientation to foster eco-innovation and maintain a competitive edge.
11	Yigit and Kanbach (2023)	Lack of structured processes and resources to implement technology-driven entrepreneurship activities	Proposed a technology-driven entrepreneurship framework for SMEs in the manufacturing sector to achieve sustainable growth.	Aligning technology-driven entrepreneurship activities can improve SMEs' core business strategies.
12	Salfore et al., (2023)	Challenges in innovating business models due to limited resources and knowledge.	Innovation in business model components such as value creation, proposition, and capture impacts SME performance.	SMEs should innovate their business models to improve performance and competitiveness.
13	Fan et al., (2023)	Struggle to navigate digital transformation, lacking clear strategies to improve innovation capabilities.	Different types of digital transformations, such as product, service, process, model, and organization, can synergistically improve the sustainable innovation capability of SMEs.	Manufacturing enterprises should combine various digital transformation strategies to improve their innovation capabilities.

14	Xiumei et al., (2023)	Lack of adaptation to environmental regulations and digital tools for compliance and innovation.	Environmental regulations and digital investment promote sustainable innovation in SMEs.	SMEs can invest in digital technologies to enhance compliance with environmental regulations and boost innovation.
15	Agasty et al., (2023)	Limited access to resources, inadequate institutional support, and lack of awareness on cleaner production.	Developed a Sustainability Innovation Index to assess and rank the innovation ecosystem for MSMEs, focusing on input and output factors.	SMEs may enhance their innovation strategies with better resource access and support systems.
16	Fernandes et al., (2023)	Mounting concerns about environmental issues	SMEs implementing sustainable innovations experience higher growth compared to those that do not practice them	Implementing Sustainable innovations can positively impact SME growth measured in terms of turnover and employment.
17	Majid et al., (2023)	Business development on creative processes and environmental sustainability	SMEs mostly rely on their resources while choosing the right eco-efficiency measure.	SMEs can utilize specific resources to reduce input materials and energy consumption costs.
18	Sun et al., (2023)	Stagnant green innovation in SMEs	Governance of innovation platforms positively influences green innovation with support of collaborative atmosphere in manufacturing SMEs	Governments should strengthen relational governance of various innovation platforms
19	Dasgupta (2023)	Pressure to develop sustainable innovations leading to economic, environmental, and social viability	Sustainable innovation initiatives are related to SMEs' product and process innovations	A focus on sustainable innovation initiatives will help SMEs bring together both monetary and non-monetary values.
20	Mokbel Al Koliby et al., (2022)	Lack of entrepreneurial competencies and innovation	Entrepreneurial competencies impact innovation and sustainable performance in SMEs	Developing entrepreneurial competencies and focusing on strategy, organization, and innovation can improve SMEs' performance.
21	Bhatti et al., (2022)	Lack of technology innovation, eco-innovation, and value proposition of the SMEs	Adopting green management practices, human capital, and technological innovation help to achieve sustainability SME	SMEs should implement green management practices and encourage staff to support eco-innovation culture
22	Lopes et al., (2022)	High cost of implementing green practices, resistance to change	By implementing sustainable practices SMEs can attain improved economic performance	SMEs that adopt sustainable innovation practices such as recycling, waste generation, and eco-efficiency have an impact on their business model, economic performance and increased market competitiveness
23	Le and Ikram (2022)	Increased consumption of resources and increased emissions	Sustainability innovation positively impacts SME competitiveness across financial, environmental, and operational performance.	Strategies for innovation by SMEs must be based on specific firm's resources and specific firm context to be doable and achievable.
24	Alerasoul et al., (2022)	Conflict between environmental sustainability and economic benefits	Higher levels of sustainability-oriented innovation and entrepreneurial performance lead to success of SMEs	SMEs should invest in resources leading to sustainability-oriented innovation
25	Khurana et al., (2022)	Concerns over sustainability issues from both governments and customers	Capacity building is a significant determinant affecting sustainable oriented innovation for SMEs	The government must support SMEs for the transition towards sustainable practices
26	Souto (2022)	Environmental degradation, social inequality	organizational creativity and sustainability-oriented innovation are critical elements for SMEs towards integration.	Integration of sustainability dimensions into all the activities of SMEs is a critical requirement.
27	Nasiri et al., (2022)	SMEs share of pollution production	Digitally oriented SME enterprises are more likely to adopt sustainable innovation	SMEs' regardless of their size or maturity, should pursue sustainable innovation
28	Aggarwal et al., (2022)	Challenges in adopting sustainable and smart manufacturing practices.	Provided a road map for manufacturing industries to adopt smart and sustainable manufacturing practices in developing economies.	Smart and sustainable manufacturing can be adopted to increase profits

29	Wysocki (2021)	High Implementation costs, limited awareness, and knowledge.	Implementing Eco-innovation enables SMEs to achieve economic and environmental goals.	SMEs should implement innovative green initiatives by integrating environmental and economic objectives
30	Tali et al., (2021)	Financial constraints and limited access to technology	Strategic business model improves product quality.	SMEs integrating higher levels of innovation-driven competitive advantage into their strategic business models are better positioned to attain sustainable growth.
31	Najib et al., (2021)	The absence of a strong innovation model and Lack of advanced manufacturing facilities	Employees' innovation potential capability and organization culture improves SMEs sustainable growth.	The employee's knowledge, mindset, attitude, and skills should collectively represent sustainable innovation
32	Virmani et al., (2021)	Production and operations-related, govt. rules and regulations	SMEs can attain success by adopting advanced manufacturing technologies by implementing industry 4.0	Industry 4.0 enables enterprises to gain real-time information about manufacturing facilities, predictive maintenance, and customer preferences.
33	Ghobakhloo et al., (2021)	Transformation to digital technology for implementing sustainability	Industry 4.0 drive sustainable innovation	Industry 4.0-enabled sustainable innovation in SMEs can foster inter-functional collaboration and learning
34	Khurana et al., (2021)	Lack of Sustainable Oriented Innovation (SOI) practices	Top management support, government initiatives, and financial resources are the important factors contributing to SOI practices.	SMEs should implement SOI practices with Top management support and organizational culture for holistic transformation.
35	Guan et al., (2020)	Limited green entrepreneurship adoption, lack of policy support, and green product innovation.	Green organizational identities enhance SMEs' green entrepreneurship image	SMEs shall invest in green organizational identity to meet consumer needs
36	Mitchell et al., (2020)	Lack of awareness of the impact on the environment, shortage of financial and human resources	Developed an online sustainability toolkit for SMEs	A systematic intervention process is necessary to help SMEs to achieve sustainability and eco-innovation prospects
37	Chen et al. (2020)	Excess production capacity and financial constraints	Overcapacity reduction policies affect enterprise R&D investment	Enhancing R&D efforts with high-quality innovation, can increase SMEs' productivity
38	Xing et al., (2020)	Weak environmental regulations impact financial performance.	Type of environmental regulations and the nature of innovation adopted will influence financial performance	SMEs organizing sustainability innovation, such as leasing equipment and outsourcing production, enhances innovation efficiency.
39	De Sousa Jabbour et al., (2020)	Lack of financial, social, and environmental performance	Innovation, governmental actions, and lean manufacturing systems are the key factors to drive SMEs' sustainable development.	SMEs can focus on Lean green manufacturing to improve environmental, social, and financial performance
40	Abbas et al., (2020)	Lack of innovation and knowledge sharing to establish learning systems	Organizational learning positively impacts the knowledge management and sustainable organizational innovation in SMEs	Implementing Organizational learning can improve SMEs sustainable innovation performance.
41	Adomako (2020)	Increased pressures from stakeholders to include environmental concerns	Environmental collaboration could help SMEs achieve greater growth than those that do not.	SME managers must be aware of the crucial impact of environmental commitment while converting environmental collaboration into sustainable innovation.
42	Lyver and Lu (2018)	Entrepreneurial actions and IT capabilities	Entrepreneurial actions towards sustainable innovation are necessary for growth and survival of firms. IT capabilities drive product innovation performance	The importance of simultaneously exploring new competencies (opportunity-seeking) and exploiting existing ones (advantage-seeking) will help SMEs to achieve improved performance.

43	Thomas et al., (2018)	Lack of support in innovation development in SMEs	The dynamics of learning and the types of innovation strategies are in relation to SMEs organisational dynamics.	Develop company culture for effective decision making which result in innovation.
44	Singh et al., (2019)	Lack of learning and dynamic capabilities for green innovation.	Enhancing green innovation boosts SMEs' efficiency, effectiveness, and core competency	SMEs should adopt eco-friendly manufacturing, encourage open dialogue for green innovation feedback.
45	Quaye and Mensah (2019)	Low integration of sustainability strategies	Innovations in product design, packaging offer a sustainable market advantage for SMEs	SMEs should prioritize marketing innovations in product design, promotion, pricing, and digital platforms to sustain market performance.
46	Ngibe et al., (2019)	Shortage of skilled labour	Innovative leadership and advanced technology are vital in manufacturing SMEs	Investing in advanced technology, SMEs can improve their manufacturing processes and align with modern business dynamics
47	Abubakar et al., (2019)	Lack of financial support	Foreign technology licensing boosts innovation among manufacturing SMEs particularly for new product and process innovation.	SME can explore technology collaboration with foreign partners
48	Kusi-Sarpong et al., (2019)	Financial limitation	Developed Multi-Criteria Decision-Making method for investigating SMEs' sustainable supply chain innovation	Manufacturing SMEs can maximize performance outcomes by focusing on their sustainability goals
49	Pacheco et al., (2018)	Cultural resistance to innovation and a lack of skilled professionals	Developed a comprehensive framework of eco-innovation tailored to emerging markets.	SMEs can create pragmatic methods to create internal processes for eco - product innovations
50	Widya-Hasuti et al., (2018)	Lack of successful technology	Process innovation can enhance firm-specific capabilities and achieving sustainable innovation in SMEs	To achieve sustainable innovation, SMEs can integrate firm-specific capabilities such as absorptive capacity, intrapreneurship, and stakeholder integration
51	Aguilar-Fernández and Otegi-Olaso (2018)	Lack of Design and implementation gaps	Firm size influences the development of sustainable business models	SMEs should innovate their models towards sustainability
52	Rezai et al., (2016)	Lack of necessary equipment, resources, and expertise to comply with sustainable practices	SME entrepreneurs adopting green practices offers valuable benefits to firm and society	Increasing awareness and education about the benefits of green practices will facilitate the transition to sustainable operations
53	Fernando et al., (2016)	Mismanagement or internal problems.	Eco-innovation practices are important across the entire value chain	By adopting eco-innovation practices, SMEs can differentiate their products and services
54	Cappa et al., (2016)	Ensuring that products are both technically viable and economically feasible remains a significant challenge.	Integrated approach of product development and production will deliver sustainable and competitive marketable products.	There is the potential for local manufacturing through collaborative integration
55	Wesseling et al., (2015)	Lack of sufficient demand.	Radical innovation often comes from less profitable firms.	The adoption of a "first mover" strategy by SMEs with a strong incentive and a strong opportunity will help to radically innovate.
56	Simboli et al., (2015)	Complex Life Cycle Assessment method	The environmental performance of a product can be improved throughout its life cycle	SMEs can implement cooperative green process development by leveraging network synergies to drive eco-innovations in supply chains.

57	Bos-Brouwers (2010)	Resource poverty	SMEs can integrate insights from sustainable development practices of other firms to enhance sustainable innovation.	A major strategy for SMEs in implementing sustainable innovation is to engage in cooperative networks
58	Thomas (2007)	SMEs do not have the technical and manufacturing infrastructure to support modern technology	Advanced Manufacturing Technology (AMT) adoption by SME will overcome the gaps in project management.	SMEs can improve their manufacturing processes, increase efficiency, and to meet customer demands by implementing AMT.

Barriers faced by SMEs

The rising challenges posed by climate change, energy crises, and deforestation have heightened the importance of sustainability, especially for Indian manufacturing SMEs. Research indicates that SMEs account for over 50% of industrial pollution in the Asia-Pacific region, contributing significantly to environmental damage and greenhouse gas emissions (De et al., 2020). Barriers such as resource constraints, lack of formalized planning, and weak external incentives prevent SMEs from adopting sustainability-oriented innovation (Pinget et al., 2015). Moreover, SMEs often perceive eco-innovation costs as a burden rather than a strategic investment, further obstructing their progress toward sustainable practices (Pacheco et al., 2018).

Sustainable innovation refers to creating products, processes, or technologies that meet human needs while preserving natural resources and supporting ecological balance (Guimarães et al., 2024). Lean and sustainability-focused innovations enhance SME competitiveness by balancing economic, environmental, and social priorities (De et al., 2020).

Collaboration with external stakeholders, such as suppliers and buyers, technical support, and shared resources, enabling them to overcome barriers to implementing sustainability-oriented innovation (Wu, 2017). Adopting such innovative strategies not only addresses environmental challenges but also ensures the long-term competitiveness and resilience of SMEs in the global market (De et al., 2020). The analysis of 58 studies reveals that key barriers faced by SMEs are a lack of innovation practices, weak infrastructure, limited digital transformation, and financial constraints. It also highlights challenges like inadequate knowledge sharing, gaps in entrepreneurial competencies, and resistance to change that hinder sustainable growth.

Strategies

SMEs should innovate their business models by adopting sustainable practices such as recycling, reducing waste, and improving eco-efficiency to respond swiftly to evolving market dynamics and enhance both performance and competitiveness. Strengthening green capabilities and aligning strategic orientation toward sustainability can further drive eco-innovation and secure a lasting competitive advantage. Moreover, fostering entrepreneurial competencies and investing in essential resources contribute significantly to sustainability-oriented innovation. Emphasizing employees' knowledge, mind-set, attitude, and skills is also crucial, as these collectively underpin sustainable innovation.

Strengthening R&D initiatives and focusing on high-quality innovation can, in turn, substantially enhance SMEs' productivity and long-term success.

Recent studies on sustainable practices in SMEs worldwide show that green innovation, government support, and stakeholder engagement are key to improving environmental and economic performance. Managerial discretion and resource-based strategies play important roles in driving sustainability, while digital orientation, eco-efficiency, and knowledge-sharing support further innovation and growth (Wu, 2017). New approaches, such as sustainability indices, highlight SMEs' adaptability and commitment to sustainability, underscoring their increasing role in sustainable development across various regions. Table 2 highlights the summary of recent research on sustainability practices in manufacturing SMEs.

Table 2
Recent Research Work on Sustainability in Manufacturing SMEs

Sl. No.	Author (s)	Country	Major Contribution
1	(Adomako and Tran, 2024)	UK and Vietnam	Stakeholder ties drive eco-innovation, improving product performance.
2	(AlKoliby et al., 2024)	Malaysia	Entrepreneurial competencies boost innovation and sustainable performance in SMEs.
3	(Omar et al., 2024)	Pakistan	By adopting green innovation initiatives and empowering managerial discretion, SMEs can enhance their environmental and economic performance, reduce waste, and gain competitive advantages.
4	(Mokbel Al Koliby et al., 2023)	Malaysia	Innovation mediates the impact of knowledge application and digital marketing on sustainable performance of SMEs.
5	(Lin et al., 2024)	Vietnam	Sustainability innovation, combined with knowledge sharing and green volunteerism, significantly boosts SMEs' entrepreneurial success.
6	(Ibikunle et al., 2024)	Malaysia	Integrating Lean Manufacturing practices and Six Sigma can boost sustainable performance in manufacturing SMEs.
7	(Majid et al., 2023)	Europe	Eco-efficiency and sustainable energy recycling boost European SMEs' financial performance.
8	(Kwak et al., 2023)	Korea	In low and medium-tech sectors, sustainable innovation driven by SMEs focuses on collaboration and architectural innovation to carve a niche in competitive markets.
9	(Fernandes et al., 2023)	European Unions	Sustainable innovation contributes positively to the growth of SMEs, with environmental practices enhance competitive advantages and profitability.
10	(Taghizadeh et al., 2023)	Oman	Learning, integrating, and coordinating capabilities drive sustainable innovation in SMEs.
11	(Xiumei et al., 2023)	Europe	Environmental regulations influence green innovation in SMEs, with digitalization amplifying these effects.
12	(Agasty et al., 2023)	India	Proposed a Sustainability Innovation Index for Indian MSMEs, providing a tool to measure innovation effectiveness.
13	(Morales et al., 2022)	Netherlands	Appropriation mechanisms like confidentiality agreements enable SMEs to protect and profit from sustainable innovations while maintaining open environmental practices.

14	(Alerasoul et al., 2022)	Italy	The integration of market and technology orientations enhances sustainable innovation performance, particularly in firms with a balanced strategic approach.
15	(Abdissa et al., 2022)	Ethiopia	Political instability, corruption, and COVID-19 significantly hinder the sustainable growth of SMEs, underscoring the need for policy reform to enhance business stability and resilience.
16	(Nasiri et al., 2022)	Finland	Digital orientation significantly enhances sustainable innovation in small businesses.
17	(Souto, 2022)	Spain	Fostering organizational creativity is essential for achieving sustainability-oriented innovation, highlighting creativity as a driver for sustainable practices.
18	(Khurana et al., 2021)	India	Government Support, Top Management commitment, Financial Resources influencing the adoption of sustainability-oriented innovation practices in MSMEs.
19	(Najib et al., 2021)	Indonesia	Top management support in food processing SMEs enhances sustainable innovation by fostering employees' innovation capabilities and an innovation-driven culture.
20	(Jun et al., 2021)	Pakistan	Government support, market demand, technology, and organizational commitment drive green innovation in SMEs.

Recent studies highlight key drivers of sustainable innovation in global SMEs, including stakeholder engagement, R&D investment, and entrepreneurial competencies, which enhance the performance of SMEs. European SMEs benefit from eco-efficiency and sustainable practices, boosting financial growth and employment. Leadership support, creativity, and market-technology integration drive innovation in SMEs. A summary of key studies outlining important contributions to the understanding of sustainable innovation practices and sustainable manufacturing strategies in SMEs are presented in Table 3. These studies explore diverse themes such as gradual innovation, integrating Industry 4.0 technologies, sustainable supply chain management, the role of environmental regulations, and the impact of organizational capabilities on innovation efficiency.

Table 3
Most Cited Research Work in Sustainable Manufacturing

Sl No.	Authors	Major Contribution	Citations
1	(Bos-Brouwers, 2010)	SMEs can improve sustainability performance by gradual innovation and stakeholder involvement.	582
2	(Kusi-Sarpong et al., 2019)	Presents a methodology that emphasizes financial accessibility to direct sustainable supply chain management in manufacturing.	247
3	(Ghobakhloo et al., 2021)	A framework connecting Industry 4.0 technology with green process innovation and sustainable manufacturing.	164
4	(Wesseling et al., 2015)	The influence of regulations and competitive incentives on the strategies of competitors in the electric car market.	78
5	(Cappa et al., 2016)	An integrated approach combining peer production and 3D printing to develop sustainable, affordable products.	61
6	(Widya-Hasuti et al., 2018)	Connects environmental legislation to financial benefits via green innovation.	44

7	(Xing et al., 2020)	Digitization and linking networks promote sustainable practices in manufacturing SMEs.	43
8	(Xing et al., 2019)	Environmental legislation improves firm sustainability via commitment and commercial innovation.	39
9	(Aguilar-Fernández and Otegi-Olaso, 2018)	Process innovation and unique business skills allow SMEs to attain sustainable innovation with limited resources.	39
10	(Golini and Gualandris, 2018)	Firm size impacts the development of sustainable business models, especially in relation to supply chain and economics modelling aspects.	38
11	(Shin et al., 2018)	Environmental improvement and safety, influence innovation efficiency.	38
12	(Lopes et al., 2022)	Organizations implementing assertive sustainable strategies help to achieve sustainability requirements and competitive benefits.	24
13	(Fan et al., 2023)	Policy-driven capacity reduction pressures incentivize sustainable innovation investments of companies.	21
14	(Chen et al., 2020)	Digital transformation in business models and structure, enhances sustainable innovation in manufacturing SMEs.	20

Challenges faced by Indian Manufacturing SMEs

Indian SMEs face challenges in adopting sustainable manufacturing practices, driven by global environmental pressures and resource constraints. Challenges primarily include limited financial resources, insufficient technological infrastructure, and barriers related to production and operations (Gupta et al., 2018; Aggarwal et al., 2022). Excessive costs associated with eco-innovations are often perceived as a burden rather than an investment, especially as many SMEs struggle with short-term financial planning (Pacheco et al., 2018). Moreover, there is often a lack of organizational and collaborative capabilities to integrate sustainable innovations effectively (Khurana et al., 2022; Chaudhuri et al., 2022).

Internal organizational hurdles, such as limited management commitment to green practices and the absence of a motivated workforce, hinder the transition to sustainable practices. Government initiatives aimed at supporting sustainable development, such as financial incentives and capacity-building programs, provide avenues for SMEs to overcome these barriers and achieve environmental and economic benefits (Khurana et al., 2022).

The SME sector in India accounts for 45% of manufacturing output and 40% of exports and provides widespread employment opportunities (DIPP, 2011). Various initiatives by the Government of India to enhance the productivity of SMEs are provided in Table 4. By addressing critical barriers such as limited financial resources, lack of technology, and operational constraints, Government initiatives aim to support SMEs in achieving competitive advantages and aligning with sustainability goals. For instance, schemes like the Credit Linked Capital Subsidy Scheme (CLCSS) facilitate technology upgrades to improve productivity, while initiatives like Digital MSME and Zero Defect Zero Effect (ZED) emphasize digital transformation and quality enhancement, encouraging SMEs to adopt sustainable practices that align with international standards.

Additionally, programs such as “Atmanirbhar Bharat Abhiyan” and “Make in India” are strategically positioned to strengthen domestic production and reduce reliance on imports, fostering self-reliance and job creation.

Table 4
Popular Schemes by Government of India to Support Indian SMEs

Sl. No.	Name of the Initiative/Scheme	Year	Focus Area	Expected Outcome
1	Atmanirbhar Bharat Abhiyan (Scheme announced during COVID-19 economic package)	2020	Self-reliance, boost local production	Strengthening local manufacturing, reduce import dependency.
2	Loan During COVID-19 (Ministry of MSME, 2020)	2020	Emergency credit for pandemic-affected SMEs	Provide liquidity to maintain operations and prevent closures.
3	Digital MSME (Ministry of MSME, 2017)	2017	Digital transformation, technology adoption	Increase efficiency, promote digital tools for operational benefits.
4	Zero Defect Zero Effect (ZED) (Ministry of MSME, 2016)	2016	Quality improvement, sustainability in SMEs	Enhance product quality, minimize environmental impact.
5	Start-up India (Ministry of Commerce and industry, 2016)	2016	Support for new and innovative start-ups	Encourage entrepreneurship, innovation, and job creation.
6	MUDRA Yojana (Ministry of MSME, 2015)	2015	Microcredit for micro and small enterprises	Enhance access to low-cost loans, support small business expansion.
7	Make in India (Ministry of Commerce and industry, 2014)	2014	Promote domestic manufacturing, increase foreign investment	Boost domestic production, enhance job creation, and attract Foreign Direct Investment.
8	PM Employment Generation Programme (PMEGP) (Ministry of MSME, 2008)	2008	Employment generation through micro-enterprises	Generate rural and urban employment, promote small-scale industries.
9	MSME Credit Guarantee Fund Scheme (CGTMSE) (Ministry of MSME, 2000a)	2000	Financial support, credit guarantees for SMEs	Improve access to collateral-free credit, support SME growth.
10	Credit Linked Capital Subsidy Scheme (CLCSS) (Ministry of MSME, 2000b)	2000	Technology upgradation	Enable modernization of machinery, improve productivity.

The Government initiatives are crucial in supporting the growth and sustainability of Indian SMEs. These include enhancing self-reliance, improving financial access, driving digital transformation, and fostering innovation. Initiatives like “Atmanirbhar Bharat Abhiyan” and make in India focus on strengthening domestic manufacturing and reducing import dependency. These initiatives resulted in empowering SMEs, to generate more employment, and enhance their competitiveness in the global market.

Table 5
Global Insights on Sustainable Practices

Sl. No	Citation	Country	Focus
1	Fernandes et al., (2023)	Europe	Resource-efficient process innovations delivering financial benefits.
2	Nasiri et al., (2021)	Finland	Digital orientation fostering sustainable innovation under technological turbulence
3	Alexandrakis et al., (2022)	Germany	Collaborative spaces enabling knowledge exchange and eco-friendly solutions.
4	Jeong and Shin, (2020)	South Korea	Government support and cooperation networks promoting organizational change.
5	Kwak et al., (2023)	South Korea	Collaboration and architectural innovation securing niche market advantages.
6	Adomako and Tran, (2024)	UK and Vietnam	Stakeholder engagement and environmental R&D enhancing eco-product innovation.
7	Taghizadeh et al., (2023)	Oman	Dynamic capabilities aiding adaptation to environmental turbulence.
8	Omar et al., (2024)	Pakistan	Managerial discretion facilitating green initiatives, improving environmental and economic performance.
9	Khurana et al., (2021)	India	Adoption of lean manufacturing and eco-friendly innovations to enhance resource efficiency.
10	Lin et al., (2024)	Vietnam	Green volunteerism and knowledge-sharing fostering collective responsibility.

Sustainable Practices in SMES

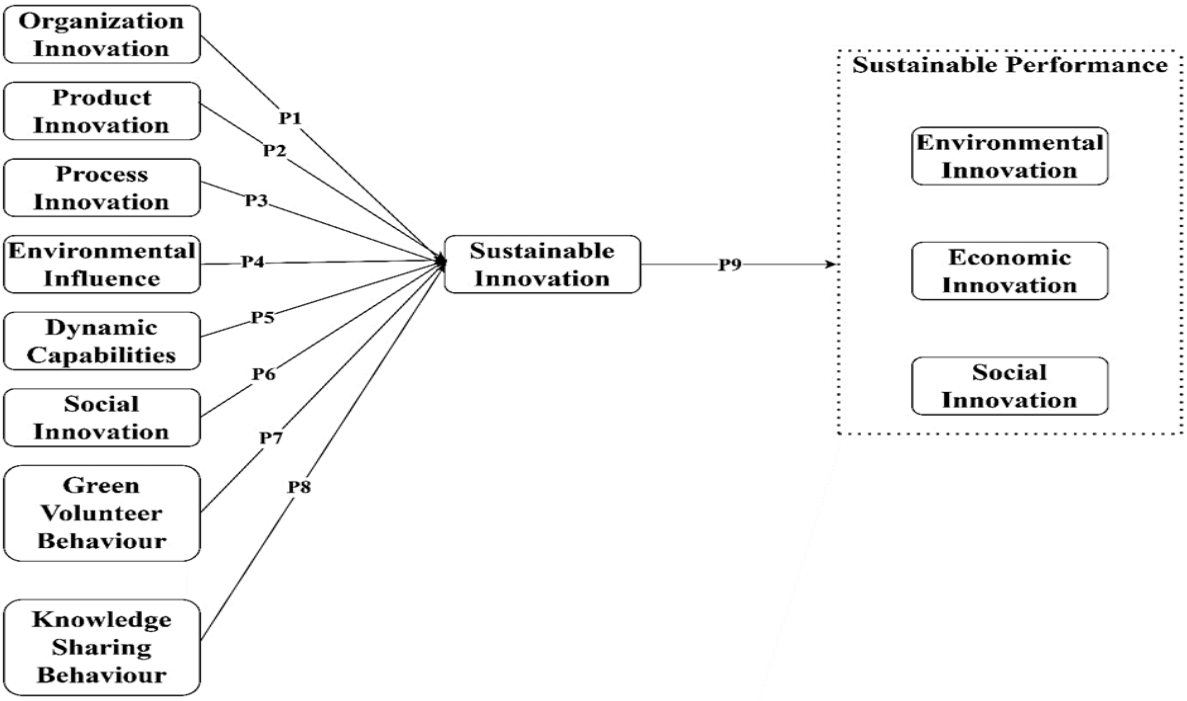
Sustainable practices followed in SMEs in other countries are presented in Table 5. In European SMEs, sustainable innovations have been found to enhance employment and turnover metrics, aligning economic growth with environmental goals (Fernandes et al., 2023). Kwak et al., (2023) observed that Korean SMEs leverage collaboration and architectural innovation to secure niche market advantages, thereby improving their sustainable performance. Dynamic capabilities enable SMEs to adapt effectively to environmental changes, which is crucial for sustaining innovation. These insights indicate that dynamic capabilities are instrumental for SMEs, equipping them to maintain sustainability despite fluctuating environmental demands. Taghizadeh et al., (2023) reveals that in Omani SMEs, learning, integration, and coordination capabilities are essential drivers of sustainable innovation. In Finnish SMEs, Nasiri et al., (2021) found that a strong digital orientation aids sustainable innovation. Lin et al., (2024) found that in Vietnamese SMEs, green volunteerism combined with knowledge-sharing practices fosters collective responsibility for environmental goals. Research on Malaysian SMEs highlights the importance of knowledge sharing in enhancing sustainable performance, especially in resource-limited contexts (AlKoliby et al., 2023).

Conceptual Model

Based on the previous research insights, best practices followed in SMEs of other countries, and expert opinion, we propose the conceptual model (Figure 1) to enhance sustainable practices in Indian Manufacturing SMEs. The novelty of this model lies in its comprehensive approach, integrating various types of innovation (organizational, product, process, and social) along with key external factors such as environmental influences, dynamic capabilities, and knowledge-sharing culture. Product and process innovations are also integral to achieving sustainable outcomes by facilitating eco-friendly product development and optimizing production processes. Sustainability-oriented innovation, which integrates ecological and social aspects into business practices, offers a comprehensive framework for addressing environmental, economic, and social objectives (Klewitz and Hansen, 2014). By linking sustainable innovation to environmental, economic, and social performance, this model offers a deeper understanding of how these elements drive sustainable growth in manufacturing enterprises in India.

Sustainable innovation, which combines environmental responsibility with economic and social benefits, has become increasingly essential for SMEs striving to maintain competitiveness and meet global standards (Nasiri et al., 2021). The sustainable performance of SMEs, which includes environmental, economic, and social dimensions, is significantly influenced by the adoption of sustainable practices. The literature reveals that dynamic capabilities, such as learning and knowledge-sharing, are vital for sustaining innovation in uncertain environments. Earlier studies highlight the importance of organizational, product, and process innovations, along with dynamic capabilities, social innovation, green volunteer behaviour, and knowledge-sharing cultures in driving sustainable innovation within SMEs (Fernandes et al., 2023; Jeong and Shin, 2020; Nasiri et al., 2022). The framework integrates the internal competencies and external resources of manufacturing SMEs to achieve sustainable innovation and competitive advantage.

Figure 6
Conceptual Model



Propositions to improve the sustainable performance of the Indian SMEs:
P1: Organizational innovation positively influences sustainable innovation in SMEs.
P2: Product innovation positively influences sustainable innovation in SMEs.
P3: Process innovation positively influences sustainable innovation in SMEs.
P4: Environmental influence positively moderates the relationship between sustainable innovation and its adoption within SMEs.
P5: Dynamic capabilities positively influence sustainable innovation in SMEs, enabling them to adapt to changing environmental conditions.
P6: Social innovation positively contributes to sustainable innovation by fostering a culture of social responsibility and collaborative practices within SMEs.
P7: Green volunteer behaviour within SMEs positively influences sustainable innovation, promoting eco-friendly practices.
P8: A knowledge-sharing culture positively impacts sustainable innovation by facilitating the exchange of ideas and best practices related to sustainability.
P9: Sustainable innovation positively affects sustainable performance, including environmental, economic, and social performance, in SMEs.

Discussion

This study provides a roadmap for Indian SMEs to adopt sustainable practices that are crucial for their long-term viability and economic contribution. The insights from this study underscore the crucial role of sustainable practices and innovation in enhancing the resilience and competitiveness of SMEs, especially within the Indian context. Sustainability and innovation are the most repeating words from Bibliometric analysis. Thus, Sustainable Development, Circular economy", "eco-innovation" and "green innovation," are becoming more important. Analysis reveals that “eco-innovation” and “open innovation” are the most trending topics, while themes such as “sustainable innovation have greater potential to be explored in SMEs.

SLR highlights that lack of innovation practices, weak infrastructure, limited digital transformation, financial constraints, and resistance to change are the major barriers that hinder the SME's sustainable growth. Sustainable innovation spans organizational, product, and process innovations, enabling SMEs to meet market demands, compliance requirements, and environmental responsibilities. Organizational innovation is instrumental in establishing the structural foundation for sustainability by empowering management and encouraging employee engagement (Omar et al., 2024). By fostering a culture of sustainability within the organization, SMEs can better integrate sustainable practices across their operations, which is essential given the financial and technological constraints they often face (Jeong and Shin, 2020). Dynamic capabilities also play a pivotal role, as they equip SMEs with the flexibility needed to adapt to external environmental changes and seize emerging opportunities for sustainability (Nasiri et al., 2022).

Taghizadeh et al., (2023) illustrate that dynamic capabilities help SMEs respond to environmental turbulence by adjusting their practices and aligning their strategies with sustainability objectives. For SMEs, the benefits of sustainable innovation are reflected in improved environmental performance, cost savings, and competitive advantages. Studies show that firms adopting eco-innovation gain improved brand reputation, consumer loyalty, and financial performance (Fernandes et al., 2023; Kwak et al., 2023). This multifaceted impact underscores the importance of sustainable innovation for long-term growth, particularly for SMEs within global supply chains that prioritize sustainability metrics. Adopting organizational innovation, dynamic capabilities, and eco-innovation, Indian manufacturing SMEs can boost competitiveness and efficiency.

The novel framework proposed in this research integrates the internal competencies and external resources of Indian manufacturing SMEs to potentially achieve sustainable innovation and product quality to meet the requirements of the domestic and global market. Sustainable measures outlined in this study enable Indian SMEs to achieve sustainable performance.

Implications

The implications of this study are far-reaching, offering valuable insights for practitioners, policymakers, and academics invested in the sustainable development of SMEs. For practitioners, particularly Indian SMEs navigating competitive and resource-limited environments, this research emphasizes sustainable innovation as essential to achieving resilience and market distinction.

SMEs have limited resources and face competitors, and their sustainability can be achieved through the appropriate trade-off between economic, environmental, and social aspects (De et al., 2020). The study emphasizes that sustainable practices, backed by organizational innovation, dynamic capabilities, and knowledge-sharing culture, are essential for SMEs to address financial, compliance, and technological challenges. By adopting sustainable practices such as waste reduction, recycling, enhancing eco-efficiency, and strengthening R&D initiatives, along with fostering entrepreneurial competencies, promoting high-quality innovation, and building green capabilities, Indian SMEs can effectively overcome barriers such as limited innovation, weak infrastructure, and slow digital transformation. By aligning with global sustainability standards, Indian SMEs can enhance efficiency, adapt to changing environmental and economic conditions, and position themselves for long-term success.

For policymakers, this research underscores the importance of fostering environments that encourage sustainable innovation among SMEs. Policy measures like financial incentives, tax breaks, and grants can provide the necessary resources for SMEs to adopt sustainable practices. Additionally, capacity-building initiatives that cultivate dynamic capabilities and promote knowledge-sharing can empower SMEs to innovate sustainably. Policymakers should consider fostering public-private partnerships and collaborative networks that link SMEs with research institutions and larger corporations, facilitating the exchange of knowledge, technology, and resources needed to navigate the complexities of sustainable practices.

Academically, this study contributes significantly to sustainable innovation research in emerging economies, especially within Indian SMEs. The developed conceptual model integrates both internal and external drivers of sustainable innovation, offering a structured framework for studying sustainability impacts on environmental, economic, and social outcomes. This model fills a gap in the existing literature by focusing on challenges and opportunities unique to Indian SMEs.

Conclusion

This study underscores the vital role of sustainable innovation practices as both a survival strategy and a competitive advantage for SMEs in an increasingly globalized and eco-conscious market. As global demand for environmentally responsible practices continues

to rise, sustainable innovation becomes a defining factor for SMEs striving to remain relevant and competitive in the global marketplace.
The conceptual model developed in this study provides a strategic framework for Indian SMEs, illustrating how sustainable practices can be systematically integrated by addressing both internal and external drivers. This model offers a structured roadmap, guiding SMEs to bridge the sustainability gap and systematically achieve growth and sustainability goals. By leveraging internal strengths, including managerial commitment and collaborative culture, alongside external resources such as strategic partnerships and supportive initiatives, Indian SMEs can establish a resilient and sustainable foundation for long-term growth.

Future research directions

For future research, several promising avenues remain unexplored. First, examining the role of digital transformation in facilitating sustainable innovation could provide valuable insights, as technological advancements have the potential to address common resource constraints faced by SMEs. Research could explore how digital tools enhance knowledge sharing, improve operational efficiency, and support eco-innovation, creating actionable strategies for SMEs. Furthermore, the potential of dynamic capabilities to harness artificial intelligence within SMEs deserves exploration, as AI-driven strategies can amplify sustainable innovation outcomes. Another critical area is supplying chain sustainability, where studies could assess how SMEs manage environmental, social, and economic challenges across their value chains.

Sector-specific studies would also be beneficial to identify tailored strategies for implementing sustainable practices across diverse industries, such as manufacturing, agriculture, and services. Exploring value chain analysis could reveal the importance placed on activities within operations and manufacturing to support sustainability initiatives. Sustainable entrepreneurship within SMEs is another promising direction, focusing on how SME owners promote a culture of continuous learning and adaptability in response to environmental turbulence. Future researchers shall also explore the need for longitudinal research on the lasting impacts of sustainability efforts on SME competitiveness and resilience.

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