

Barriers to the Adoption of Green Finance in India with Special Reference to Small & Medium Enterprises (SMEs)



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Abstract

Importance: Green finance has become a critical policy instrument for promoting sustainable development by directing financial resources toward environmentally responsible activities and supporting the transition to a low-carbon economy.

In India, one of the essential pillars of economic growth is SME, their engagement with green finance remains finite. Hitherto, multiple green finance initiatives and supportive policy tools have been implemented; however, SMEs encounter various impediments that restricts its effective adoption. Available studies and research underscore the need for better empirical evidence to elucidate how policy and institutional mechanisms affect green finance uptake among SMEs.

Objective: This study focuses on key policy, institutional, and financial barriers affecting green finance adoption among Indian SMEs and examines whether the understanding of these barriers varies across enterprise characteristics.

Methods: The study of primary data was collected from 90 SMEs units and their administration holders using a structured, self-administered questionnaire. Data were analysed using SPSS version 25. Descriptive statistics, Exploratory Factor Analysis (EFA), reliability analysis, and Analysis of Variance (ANOVA) were employed to identify major barriers and assess variations across industry type, enterprise size, and years of operation.

Results: The findings illuminate that the most critical constraint to green finance adoption is policy and regulatory barriers, in line accompanied by institutional and financial barriers. Factor analysis pinpointed three dominant dimensions moulding adoption behaviour. There are no significant differences in perception across SME characteristics as per ANOVA results, spotlighting the fact that barriers are systemic and not enterprise-specific. There is a strong preference for subsidised loans, tax incentives, and simplified eligibility criteria, as highlighted by descriptive results. Most of the SMEs respondents inclined interest in adoption if policy and procedural barriers are surge-down, and underscore that green finance is vital for long-term sustainability.

Keywords: Green Investment, Green Finance, Green Economy, Sustainability, Indian SMEs, Financial barriers, Policy & Regulatory barriers and Institutional barriers.

1. Introduction

At the grassroots level of economic development in the Indian context the SMEs plays very critical role, moreover they encompasses not less than 111 million people directly or indirectly. As environmental degradation causes misalignment in the performance and operational excellence of the SMEs, howsoever, the sector is much promising in the presence of methods of production and consumption becomes more sustainable and environmentally cordial.

Green finance has emerged as a critical component of economic policy and business strategy due to the rapid transformation of the global financial system toward sustainability. These SMEs play a very crucial role in the success of these initiatives, since they

account for a substantial share of India's industrial output and employment generation. Green finance as a driver for sustainable development, getting global recognition; however, its adoption and use within India's SME sector is looming due to several financial, operational and institutional barriers (Bharati & Patra, 2022).

Green finance has emerged as an important mechanism for aligning business growth with environmental responsibility. Sustainability goals and economic progress are furthered via green finance, and furthermore, motivating firms to integrate climate considerations into their operations. Need to reframe the progress, because lacunas are there, such as regulatory uncertainty, lack of institutional preparedness, and the absence of

uniform green finance frameworks (Chandran, Chandran, & Achuthan, 2025).

In the present scenario, where the world is confronting accelerated threats of climate change and environmental degradation, it is indispensable to integrate sustainability principles into financial systems. There is a high need that policymakers, financial institutions, and scholars worldwide push attention towards green finance. Green Finance is a financial investment that facilitate sustainable operations and initiatives, environmental items, and policies that assist a more sustainable economy (Bhardwaj & Narula, 2022; Mallin, 2019).

The concept that is Green Finance has gained utter significance in the Indian context, this is due to rapid industrial acceleration, rising energy demands, and global commitments for environment protection. Towards employment generation and boosting economic growth SMEs play a very fundamental role in the context of India. There are pertinent impediments, related to SMEs, in adopting green finance mechanisms and hold upon environmentally sustainable technologies (Bapat et al., 2023; Mohanty et al., 2025). Use and establishment of sustainable green manufacturing practices in SMEs in fundamentally seen as a roadmap to a new green revolution in India (Bapat et al., 2023), linking economic growth with ecological preservation.

However, its wide adoption is obstructed due to several structural and institutional gaps, this is despite having green finance potential. Barriers such as regulatory uncertainty, lack of green financial instruments, limited awareness, and inadequate institutional frameworks, among others (Chandran et al., 2025; Jaura, 2023; Sethi, 2025).

Due to complexity of aligning financial systems with sustainability goals there exist a mismatch between available green funding and financing needs of SMEs (Beck et al., 2006). The role of financial institutions and regulatory frameworks is highlighted in filling the gap by adopting and growing innovative policies, sustainable credit lines, and incentive based financing models (Thapliyal et al., 2024; Beck et al., 2006).

The rise of institutional investors and green bonds, which play a transformative role in financing renewable energy and sustainable business models for green finance, has gained momentum globally (DellaCroce et al., 2011). In emerging economies, such as those in Latin America and South Asia, governments and international organisations have initiated green financial policies to promote sustainable entrepreneurship and reduce environmental impact (Diaz-Roldán & Sánchez, 2022; Chandrayanti et al., 2023). The Indian government's green banking initiatives and the Reserve Bank of India's (RBI) sustainability guidelines have provided a foundation, though adoption remains uneven across regions and sectors (Chandran et al., 2025;

Thapliyal et al., 2024).

Statistical studies have underscored the positive impact of green finance on macroeconomic and enterprise performance. The performance of banking portfolios in emerging economies, especially through SME credit channels with the help of green lending, as demonstrated by Mirza et al. (2023). By aligning investments for energy, waste management, and eco-friendly industrial processes, green finance has contributed to sustainable development as presented by Gunjan and Keerti (2024). Innovation and digital transformation are key enablers in mitigating the barriers to sustainable and green financing, linking it with the UN SDGs, as identified by Raman et al. (2025).

For targeting sustainability and economic resilience in India, the adoption of green finance through SMEs is seen as a crucial strategy (Mohanty et al., 2025; Pradhan & Venkat Krishna, 2024). The operational strategies of SMEs are being modified for green entrepreneurship practices guided by environmentally conscious business models (Nafeesa & Joe, 2024). Some of the underscored obstacles are limited access to green credit, lack of investor confidence, and insufficient policy coherence (Bharati & Patra, 2022; Jaura, 2023). The interoperability of financial, institutional, and technological challenges that inhibit the effective execution of green financing in India, is underscored by the study of Sethi (2025).

Sector-specific studies also illustrated that how targeted financial interventions can transform local economies. To mention, Radhika and Sivabagyam (2024) investigate the manufacturing sector in Coimbatore, finding a profound positive relationship between green finance and environmental performance. Similarly, Perwez and Safiuddin (2024) accentuate the importance of green financing in India's renewable energy sector, which not just surge down carbon emissions but also concretises the financial sustainability of energy producers.

There is an impetus for financial innovation as well as policy coherence for transitioning towards a green economy. Regulatory support, institutional capacity-building, and technological innovation are integrated approaches that can provide more efficiency and effectiveness for a more resilient green financial ecosystem- many studies have suggested this (Raman et al., 2025; Sharma et al., 2025). Effective regulatory frameworks and incentives are vital to encourage private sector involvement with respect to green banking (Chandran et al., 2025). Favourably, green finance not only demarcates environmental risks hand-in-hand creates competitive advantages for businesses that pursue sustainable executions (Bhatnagar, 2025; Mallin, 2019).

This study makes an empirical contribution by identifying the principal challenges influencing the adoption of green finance among SMEs and classifying them into policy and regulatory,

institutional, and financial categories through statistical techniques. It further evaluates whether these perceived challenges vary across different SME characteristics and finds that they are predominantly systemic rather than specific to individual firms. The findings offer evidence-based insights that can assist in designing more effective policy measures and strengthening institutional frameworks to enhance access to green finance in India and transition toward a sustainable, low-carbon future.

Review Of Literature

Climate mitigation, climate resilience, sustainable resource use, and the advancement of a low-carbon economic system are contributed by supporting environmentally responsible projects and enterprises aimed by green finance broadly denotes the mobilisation of financial instruments and policy measures (Bhardwaj & Narula, 2022; Mallin, 2019). Governance frameworks that embed environmental risk considerations into financial evaluation and investment decisions, it also encompasses purpose-driven financial tools such as green bonds, concessional green credit, climate-oriented funds, and sustainability-linked investments. Align Financial systems with sustainability objectives by channelling capital toward environmentally responsible activities, as green finance is increasingly viewed as a strategic mechanism (Mishra & Kannaujia, 2023).

Theoretical Foundations and Conceptual Framework

Current scholarship positions green finance within the broader domains of sustainable finance and institutional theory. Regulatory frameworks, market mechanisms, and organisational behaviour are converging within green finance (Mallin, 2019). The role of regulatory institutions and institutional investors in shaping both the supply and structure of green financial instruments is highlighted (Chandran et al., 2025 and DellaCroce et al., 2011). Collectively, these studies support a layered analytical framework comprising three levels:

- Macro-level actors and policy instruments, including governments, regulators, and institutional investors.
- Financial intermediaries such as banks and green capital markets.
- Firm-level adoption, particularly among SMEs.

Green Finance Instruments

- **Green bonds** are settled income securities specifically issued to bring out capital for projects with productive environmental benefits, such as renewable energy, energy efficiency, clean transportation, and pollution prevention. To ensure transparency and accountability in the use of proceeds, these bonds follow

established frameworks and standards (International Capital Market Association [ICMA], 2021; OECD, 2017).

- **Green loans** are credit potentials provided to businesses or projects that meet pre-defined environmental criteria. Differing from conventional loans, green loans often take into account sustainability-linked performance indicators and would offer preferential interest rates to facilitate environmentally responsible investments (UNEP, 2016; World Bank, 2020).
- **Green equity investments** involve direct investment in enterprises or projects that prioritise sustainability, clean technologies, and environmentally suitable business models. These investments aim to generate long-term financial outcomes while encouraging the shift to a low-carbon and resource-efficient economy (Mallin, 2019; Bhardwaj & Narula, 2022).
- **Climate-related insurance products** are modelled to manage and transfer climate-related menace, such as extreme weather events, floods, droughts, among others. These insurance facilities enhance financial resilience by shielding businesses, communities, and governments from climate directed losses and assist climate adaptation strategies (OECD, 2021; World Bank, 2019).
- **Risk Management** to better up investment sustainability and financial stability, the amalgamation of environmental and climate-related risks, such as physical and transition risks, into financial analysis and decision making (UNEP, 2016; TCFD, 2017).
- **Policy and Regulation Government and financial authorities** have listed out regulatory frameworks, guidelines, and incentive mechanisms to emphasise and promote investments towards environmentally sustainable activities and encourage the shift towards a low-carbon economy (UNEP, 2016; OECD, 2017).

The literature identifies a varied mix of instruments that operationalise green finance. In financing large-scale clean energy initiatives, the role of institutional investors and capital market instruments, especially green bonds, is underscored (DellaCroce et al., 2011). The relevance of banking-led mechanisms, which include green lending and targeted credit products, supports renewable energy projects and influences banks' credit portfolios (Perwez and Safiuddin, 2024 and Mirza et al., 2023). Regulatory design can either facilitate or constrain green investment mobilisation, economies of broader investment and policy frameworks governing green capital flows in

emerging economies (Bhatnagar, 2025 and Bhardwaj and Narula, 2022).

SME-Level Green Finance Initiatives in India

At the enterprise level, public policy initiatives, development finance, and emerging market-based approaches work as a combination for the development of green finance for SMEs in India. Institutions such as SIDBI, a government supported, provide financing for energy-efficient technologies, renewable energy adoption, and pollution-control measures through concessional interest rates, refinancing support, and longer repayment periods, which helps in easing financial constraints faced by SMEs (Bhardwaj & Narula, 2022; Mallin, 2019).

Along with credit provision, many programs integrate financial support with technical assistance, energy audits, including capacity-building initiatives, and project-preparation services. Such measures help SMEs better assess project feasibility and address information gaps that increase lender risk perceptions (Bharati & Patra, 2022; Jaura, 2023). SMEs are able to access preferential funding by meeting sustainability standards or through public-private risk-sharing arrangements, which are enabled by market-led mechanisms like supply-chain-linked green finance and blended finance

models, which are gaining prominence (DellaCroce et al., 2011; Mirza et al., 2023).

Incentives, institutional facilitation, and risk mitigation, rather than mandatory regulation, are the primary tools on which SME related green finance initiatives in India rely upon. The above initiatives demonstrate the ability of targeted policy support and innovative financing structures to solidify SME participation in the green transition, although their adaptation varies across sectors (Bapat et al., 2023; Mohanty et al., 2025).

SMEs: Role and Adoption Challenges

There are disproportionate barriers in accessing green finance and adopting environmentally sustainable technologies by SMEs, this is despite gaining a pivotal forum in sustainable development due to their contribution to employment and economic processes (Bapat et al., 2023; Mohanty et al., 2025). SMEs' access to finance, including green financial products, is directly influenced by the structure and efficiency of financial systems directly (Beck et al., 2006). Information asymmetries, limited awareness of green finance options, insufficient collateral, heightened risk perceptions, and regulatory ambiguity are a few commonly listed constraints (Bharati & Patra, 2022; Jaura, 2023; Sethi, 2025).

Table 1: Challenges in Green Finance Adoption among SMEs

Category of Challenge	Description of Challenge	Author
Financial Constraints	SMEs face difficulties due to high initial costs of green investments and limited access to affordable credit, which discourages participation in green finance initiatives.	Bharati & Patra (2022)
Limited Awareness	Inadequate knowledge about available green finance schemes and instruments restricts SMEs' ability to utilise such financing options effectively.	
Institutional Barriers	Weak institutional support structures and a lack of specialised financial intermediaries reduce SMEs' engagement with green finance mechanisms.	
Policy and Regulatory Complexity	Complicated procedures, unclear guidelines, and frequent policy changes create uncertainty and increase compliance burdens for SMEs.	
Risk Perception	Green projects are often perceived as risky due to uncertain returns and long payback periods, making SMEs hesitant to adopt green finance.	

Enablers and Innovation in Green Finance Adoption

Many studies identify mechanisms that can eliminate adoption barriers. For enhancing scalability and reducing transaction costs associated with green finance, digital technologies and fintech platforms are

highly pointed out as enablers (Raman et al., 2025). To make adoption rates better, capacity-building initiatives, which also include targeted training for SMEs, along with concessional finance, credit guarantees, and customised green financial products (Chandrayanti et al., 2023; Thapliyal et al., 2024). In mobilising larger capital pools to complement

traditional bank financing, blended finance models and institutional investor involvement are underscored as essential (DellaCroce et al., 2011; Mirza et al., 2023).

Sectoral and Regional Evidence

Important sector and region-specific insights into green finance outcomes are provided by empirical studies. In Coimbatore's manufacturing sector, there is a positive relation between green finance utilisation and environmental performance, demonstrating the effectiveness of localised interventions (Radhika and Sivabagyam, 2024). For green finance deployment, renewable energy is identified as a particularly suitable sector (Perwez and Safiuddin, 2024). Despite Contextual institutional differences, there are many adoption barriers and enabling factors that are common across emerging economies, highlighted from Comparative studies on Latin American SMEs (Diaz-Roldán & Sánchez, 2022).

Banking Performance and Financial Implications

The financial implications of green lending for banks have been examined by growing body of research. When environmental risks and opportunities are adequately integrated into credit assessment processes, green lending is compatible with stable banking performance (Mirza et al., 2023). Reinforcing the needed alignment between environmental objectives and financial soundness, by green banking practices add to improved environmental performance among banks (Thapliyal et al., 2024).

Policy, Regulation, and Institutional Dynamics

Policy coherence and regulatory certainty are some recurring themes in the literature. To decrease uncertainty and attract private investment, the significance of clear regulatory frameworks, incentive-based mechanisms and standardised green taxonomies (Chandran et al., 2025; Jaura, 2023; and Sethi, 2025). For channelising institutional capital toward SME-oriented green projects several studies spotlight the strategic role of central banks, finance ministries, and ecosystem-level institutions in providing market signals and de-risking instruments (Beck et al., 2006; Mallin, 2019).

Implications

By requiring coordinated action among policymakers, financial institutions, and enterprises, green finance is portrayed as a system-level challenge. There are challenges as well as opportunities for impactful green finance interventions in the Indian context of SME sector (Bapat et al., 2023; Mohanty et al., 2025). For delivering environmental benefits without compromising financial performance, well-designed green lending frameworks supported by appropriate

policy measures have been suggested by empirical evidences (Mirza et al., 2023; Thapliyal et al., 2024).

Green Finance Flows and De-Risking Model:

The Green Finance Flows and De-Risking Model developed by Taghizadeh-Hesary and Yoshino (2020) elucidates how financial risks stand as a major impediment to mobilising capital for a low-carbon and environmentally sustainable outline. Green investments-renewable energy, energy efficiency, and clean technology to mention for few- often face greater risks compared to conventional investments, as mentioned by authors. Uncertain regulatory environments, lack of market maturity, technological challenges, and long payback periods are some of the points from risks that may arise. Capital flows are essential for climate mitigation and sustainable development; however, due to volatility and associated risk, private investors frequently view green projects as unattractive, leading to insufficient capital flows.

The model highlights that de-risking mechanisms are essential to overcome these barriers. Public-sector tools such as government guarantees, interest rate subsidies, tax incentives, concessional loans, and public-private partnerships (PPPs) play a crucial role in reducing investment risks. Financial mechanisms like blended finance further support the sharing of risks between public and private actors. As risks decline, private sector confidence increases, leading to expanded investment flows into green sectors. Ultimately, the model demonstrates that strategically designed de-risking policies can significantly scale up green finance, support the transition to a low-carbon economy, and enhance long-term environmental and economic sustainability.

- Taghizadeh-Hesary and Yoshino propose a model showing how financial risks limit investment in low-carbon and green projects.
- The model explains that green investments face high perceived risks (market, technology, and policy risks), making private investors reluctant.
- They highlight de-risking mechanisms—such as guarantees, interest subsidies, blended finance, and risk-sharing between public and private sectors—to attract capital.
- The model also analyses green finance flows, showing how improved risk mitigation increases investment volume in renewable energy and sustainable infrastructure.

Overall, it provides a policy-focused approach to mobilising sustainable finance by reducing investor risk and improving financial system efficiency.

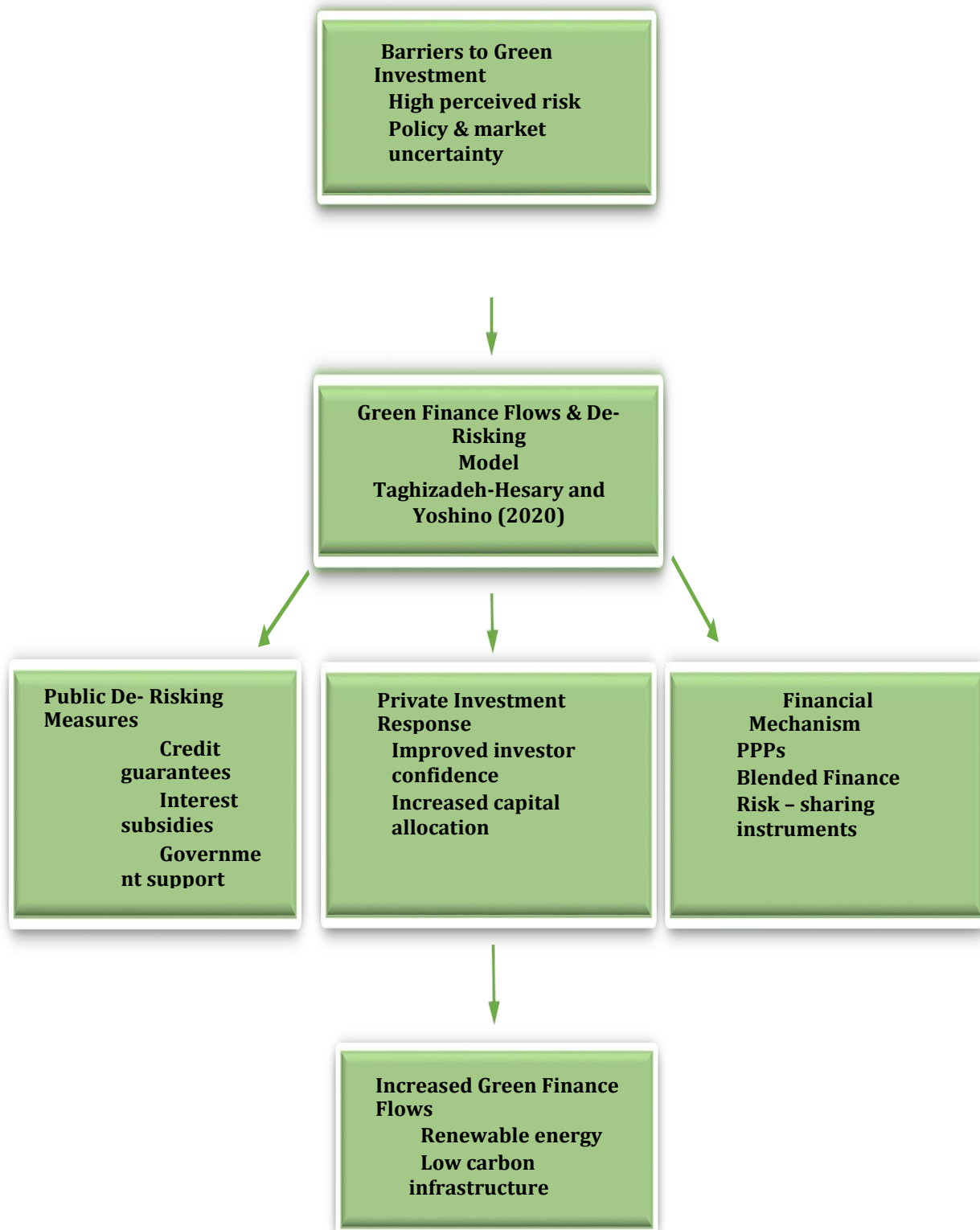


Figure 1 illustrates how high perceived risks create barriers to green investment and how public de-risking measures, financial mechanisms, and private investment responses interact to increase green finance flows toward renewable energy and low-carbon infrastructure.

Research Gap

The prevalence of green finance by SMEs is limited, despite the introduction of several green finance policies, incentive mechanisms in India, and regulatory frameworks. As the existing literature has insufficient empirical evidence on how these policies

function at the firm level, it greatly concentrates on macro-level policy design, financial instruments, and institutional intentions. There are practical challenges that SMEs face while accessing green finance, such as procedural complexity, regulatory uncertainty, and limited clarity regarding eligibility

and compliance requirements, and there is a lack of systematic investigation into these.

Without sufficiently integrating policy and regulatory constraints into a unified analytical framework, many of the earlier studies examine financial or institutional barriers in isolation. A comprehensive understanding of how policy-related factors interact with financial and institutional limitations to affect green finance adoption is restricted by such fragmented approach. Moreover, empirical studies seldom assess whether perceived policy barriers vary across enterprises, characteristics such as industry type, firm size, or years of operation, leaving an important gap in evidence-based policy evaluation.

For changing green finance adoption among Indian SMEs, this study addresses gaps by providing firm-level empirical insights into policy, regulatory, institutional, and financial barriers. The research aid to provide policy-relevant evidence aimed at improving the effectiveness, accessibility, and implementation of green finance initiatives in India, by analysing the uniformity and intensity of these barriers by using primary data and statistical methods.

Research Method

This study adopts a primary data-based research design to examine the adoption of green finance among small and medium enterprises in India. Primary data were collected directly from relevant stakeholders, including SME owners, managers, and financial professionals, using a structured questionnaire designed around green finance awareness, adoption, challenges, and perceived outcomes. Quantitative data are analysed using appropriate statistical tools to identify patterns, relationships, and key influencing factors affecting the adoption of green financial practices

A quantitative approach was employed to ensure objective measurement and analysis of responses. The sampling technique followed a purposive and convenience-based method to capture respondents with practical exposure to green financial practices. Data were analysed using appropriate statistical tools to assess relationships between green finance variables and sustainability outcomes, ensuring reliability and validity of the findings

Research Objective

1. To identify the major barriers faced by SMEs in adopting green financial initiatives.
2. To study the perception about barriers across SMEs' characteristics.

Hypothesis

- H1. The perceived barriers to green finance significantly differs across types of industry.
- H2(a). Enterprise size has a significant effect on financial barriers to green finance.

H2(b). Enterprise size has a significant effect on Institutional barriers to green finance.

H2(c). Enterprise size has a significant effect on Policy and Regulatory barriers to green finance.

H3. Years of operation are significantly associated with perceived financial barriers

Sampling Technique and Sample Size

The study employed a non-probability sampling technique, purposive sampling, to select respondents with relevant knowledge and experience in green finance practices. Small and medium enterprises (SMEs) were chosen based on their involvement in financial decision-making and potential engagement with sustainability initiatives.

A total of 90 SMEs constituted the sample size for the study. This sample was considered adequate to obtain meaningful insights into green finance awareness, adoption, and challenges, while allowing for reliable quantitative analysis within the scope of the research.

Data Sources and Collection Method

The research is primarily based on primary data to ensure the accuracy and relevance of information related to green finance practices. Primary data were collected directly from small and medium enterprises (SME) owners and managers through a structured questionnaire. The questionnaire was designed to gather data on awareness, adoption, challenges, and perceived benefits of green finance. The questionnaire comprised five sections. Section A consisted of six questions capturing the demographic profile of the respondents. Sections B, C, D, and E included items measuring identified categories of barriers and challenges related to green finance, namely Financial Barriers, Institutional Barriers, Policy and Regulatory Barriers, and Overall Challenges and Perceptions.

All items in Sections B to E were measured using a standardised 5-point Likert scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree, to assess respondents' levels of agreement with each statement. The adoption of this scale ensured consistency in measurement and facilitated robust quantitative analysis of the perceived barriers to green finance adoption among SMEs. The data collection process involved administering the questionnaire through direct interactions and electronic modes, ensuring a higher response rate and clarity of responses. The collected data were systematically reviewed, coded, and prepared for statistical analysis.

Data Analysis Procedure and Tools

The collected data were coded and analysed using SPSS version 25. Descriptive statistics were used to summarise the demographic profile of the respondents and the questionnaire responses. Exploratory Factor Analysis (EFA) was applied to

identify the underlying factor structure of items related to barriers to green finance adoption among SMEs. The suitability of the data for factor analysis was confirmed using the Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s Test of Sphericity. Reliability of the measurement scale was assessed using Cronbach’s alpha. Analysis of Variance (ANOVA) was employed to examine differences in perceptions

across demographic and firm-related characteristics. The study was based on responses from 90 SME owners and managers.

Analysis And Interpretation

Descriptive Statistics Demographic Profile Table 2 Percentage Analysis: Gender, Age, Designation in the organisation, Type of industry, Size of enterprise and Years of operations.

S. No	Particulars		Frequency	Percentage
1	Gender	Male	73	81.1
		Female	17	18.9
		Total	90	100.0
2	Age	35-45	16	17.8
		46-55	45	50.0
		56- Above	29	32.2
		Total	90	100.0
3	Designation in the organization	Owner/Founder	37	41.1
		Manager/Administrator	42	46.7
		Financial Officer	11	12.2
4	Type of industry	Manufacturing	46	51.1
		Services	27	30.0
		Trading	17	18.9
		Total	90	100.0
5	Size of enterprise	Small	53	58.9
		Medium	37	41.1
		Total	90	100.0
6	Years of operation	Less than 5 years	13	14.4
		5-10 years	18	20.0
		11-20 years	34	37.8
		More than 20 years	25	27.8
		Total	90	100.0

The above table presents the demographic profile of SMEs included in the study. The sample consisted of 90 respondents comprising owners, managers/administrators, and financial officers operating within the SME sector. Among the respondents, 81.1% were male, and 18.9% were female, indicating a predominance of male participation in SME leadership and financial decision-making roles. With regard to age distribution, 17.8% of the respondents belonged to the 35–45 age group, 50% were between 46–55 years, and 32.2% were above 56 years, suggesting that a majority of decision-makers in SMEs are experienced individuals in mid to late career stages. In terms of organisational roles, 41.1% of

respondents were owners or founders, 46.7% were managers, and 12.2% were financial officers, reflecting a balanced representation of strategic and operational perspectives. Industry-wise, 51.1% of respondents were from the manufacturing sector, followed by 30% from services and 18.9% from trading, indicating a strong representation of manufacturing-oriented SMEs. Furthermore, 58.9% of the sample comprised small enterprises, while 41.1% were medium enterprises. The years of operation reveal that 14.4% of SMEs have been operating for less than five years, 20% for 5–10 years, 37.8% for 11–20 years, and 27.8% for more than 20 years, demonstrating a mix of emerging and well-established enterprises.

Frequency of Access to Bank Loans or External Financing for Green Projects

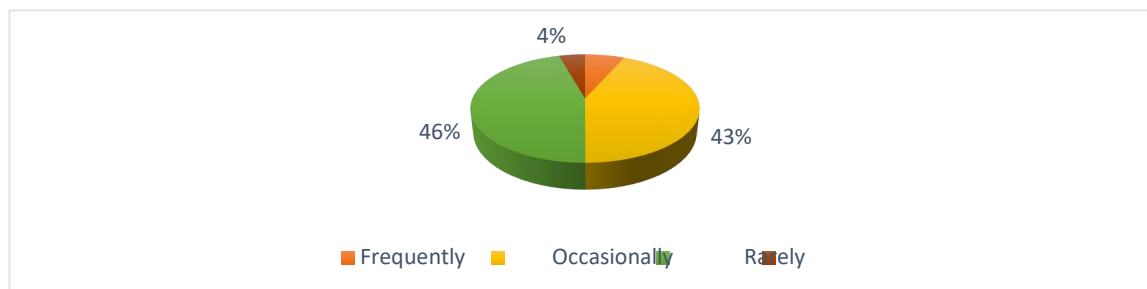


Figure 2 illustrates the frequency with which enterprises access bank loans or external financing for green or sustainability-related projects.

The results show that a majority of enterprises access bank loans or external financing for green or sustainability-related projects either rarely (45.6%) or occasionally (43.3%). Only (6.7%) of enterprises reported frequent use of such financing, while (4.4%) indicated that they never

access bank loans or external financing for green projects. This indicates a generally low to moderate

level of engagement with formal financing sources for sustainability-related initiatives among enterprises. High upfront costs of green technologies, strict collateral requirements, and limited access to long-term credit discourage firms from seeking formal financing. In addition, partial awareness of green finance schemes and regulatory complexity reduces enterprises' ability to engage with financial institutions.

Preferred Financial Support for Adoption of Green Technologies

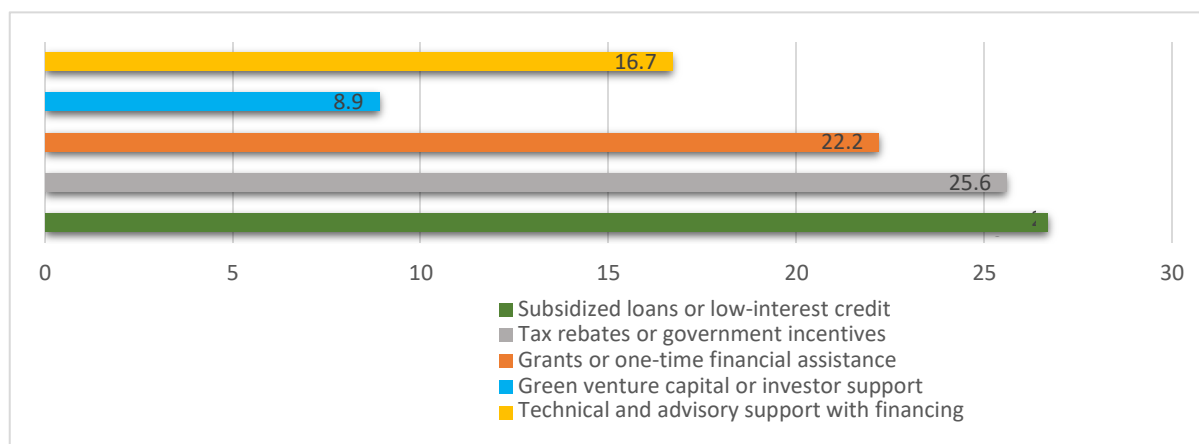


Figure 3 presents a comparative analysis of different types of financial support preferred by enterprises for adopting green technologies.

The results indicate that subsidized loans or low-interest credit (26.7%) are the most preferred form of financial support to encourage SMEs to adopt green technologies. This is closely followed by tax rebates or government incentives (25.6%) and grants or one-time financial assistance (22.2%), highlighting the importance of direct financial relief mechanisms. Technical and advisory support linked with financing (16.7%) also plays a notable role, while green

venture capital or investor support (8.9%) is the least preferred option among respondents. Overall, the findings suggest that SMEs favour low-risk and cost-reducing financial instruments over equity-based financing. SMEs typically operate with constrained cash flows and limited risk-bearing capacity; therefore, debt instruments with concessional terms and fiscal incentives are perceived as more predictable and manageable than equity-based financing.

Enterprise Confidence in Evaluating Green Technology Options

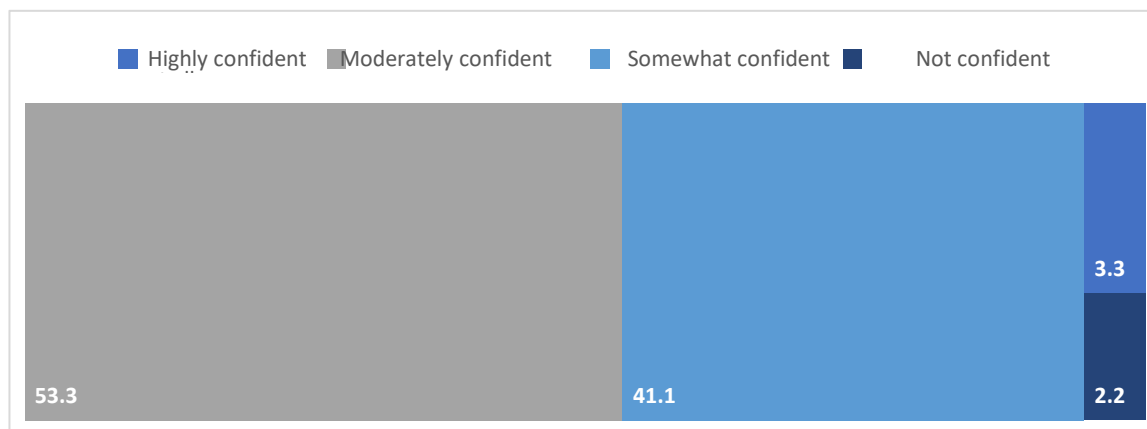


Figure 4 illustrates the confidence level of enterprises in evaluating green technology options.

The findings indicate that most enterprises possess a moderate level of confidence in evaluating green technology options. A majority of respondents reported being moderately confident (53.3%), followed by somewhat confident (41.1%), suggesting partial familiarity with green technologies. Only a

small proportion of enterprises indicated being highly confident (3.3%), while 2.2% reported being not confident at all. This reflects a need for greater technical knowledge and advisory support to enhance confidence in evaluating green technology solutions.

Preferred Technical Assistance for Adoption of Green Finance

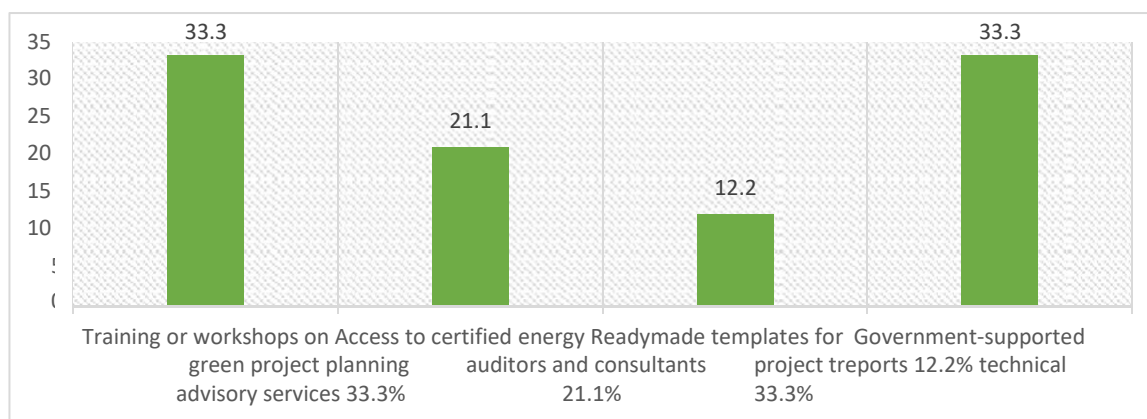


Figure 5 depicts the types of technical assistance preferred by enterprises for adopting green finance.

The results indicate that training or workshops on green project planning (33.3%) and government-supported technical advisory services (33.3%) are the most preferred forms of technical assistance to facilitate the adoption of green finance. This is followed by access to certified energy auditors and consultants (21.1%), highlighting the importance of

expert guidance. Readymade templates for project reports (12.2%) were the least preferred, suggesting that enterprises place greater value on capacity building and advisory support rather than standardised documentation alone. This indicates that SMEs perceive green finance adoption as a complex process requiring technical understanding, regulatory clarity, and project-specific customisation.

Awareness of Government Schemes Promoting Green Financing for SMEs

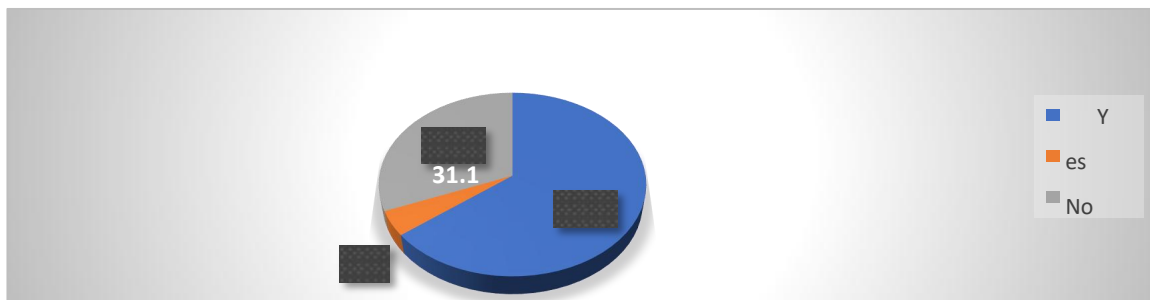


Figure 6 illustrates the level of awareness of government schemes promoting green financing among SMEs.

The findings reveal that a majority of respondents (64.4%) are aware of government schemes that promote green financing for SMEs. However, 31.1% of respondents indicated uncertainty by selecting “Maybe,” suggesting partial or unclear awareness of

such schemes. A small proportion (4.4%) reported having no awareness of government initiatives related to green financing. This indicates that while general awareness exists, there is a need for improved communication and clarity regarding available schemes.

Policy Measures Supporting SMEs' Access to Green Finance



Figure 7 presents the policy measures perceived as most effective in supporting SMEs' access to green finance.

The responses indicate that simplified eligibility criteria for green loans (32.2%) are perceived as the most effective policy measure to support SMEs in accessing green finance. This is followed by enhanced subsidies and tax incentives (25.6%), highlighting the importance of financial incentives in encouraging green investments. Awareness campaigns for MSME owners (17.8%) and single-window clearance for

green finance applications (14.4%) were also identified as important measures. In contrast, mandatory inclusion of green lending targets for banks (10%) received the least support, suggesting a preference for facilitative rather than regulatory approaches. Overall, the findings imply that policy effectiveness depends on reducing complexity, improving incentives, and strengthening outreach rather than imposing strict compliance requirements.

Primary Reasons for Non-Adoption of Green Finance among SMEs

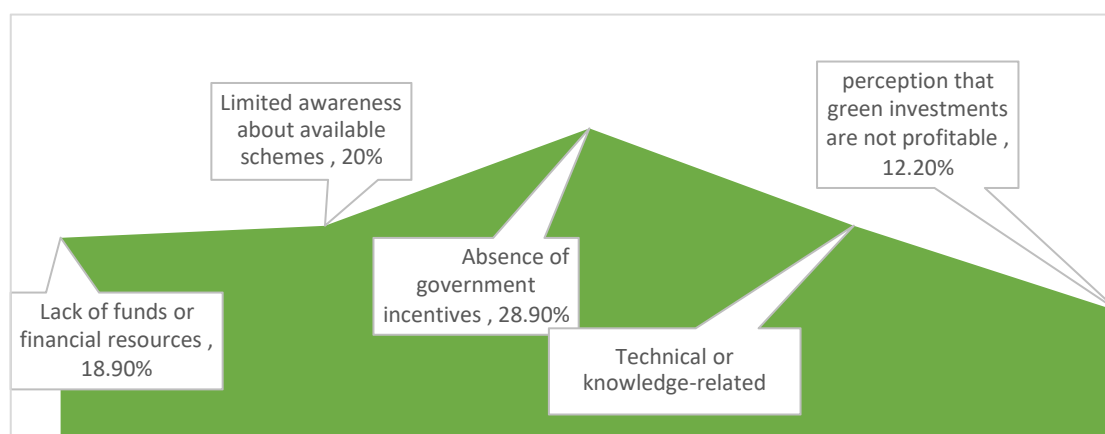


Figure 8 illustrates the distribution of reasons for non-adoption of green finance.

The results indicate that the absence of government incentives (28.9%) is the primary reason why enterprises have not adopted green finance. This is followed by limited awareness about available schemes (20%) and technical or knowledge-related limitations (20%), highlighting information and capability gaps. Lack of funds or financial resources (18.9%) is also a significant constraint. In contrast,

the perception that green investments are not profitable (12.2%) was reported as the least influential reason, suggesting that profitability concerns are secondary to policy and awareness-related barriers. The dominance of policy- and information-related constraints indicates that enterprises are more constrained by external support mechanisms than by doubts about the economic viability of green investments.

Perceived Importance of Green Finance for Long-Term Enterprise Sustainability

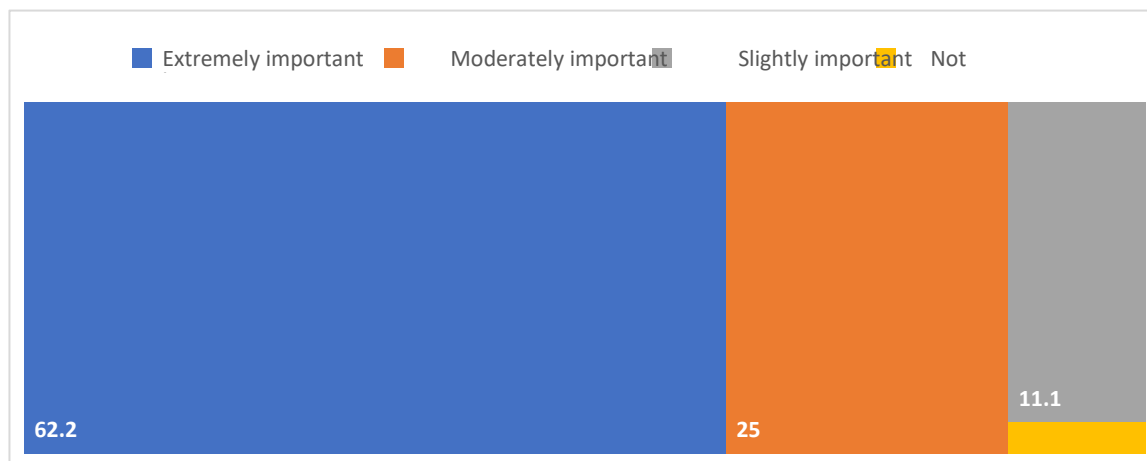


Figure 9 illustrates the perceived importance of green finance for the long-term sustainability of enterprises.

The results clearly indicate that enterprises place high importance on green finance for long-term sustainability. A majority of respondents (62.2%) perceived green finance as extremely important. These findings highlight a strong recognition among SMEs of the strategic role of green finance in ensuring long-term sustainability.

Interest in Future Green Financing Opportunities under Reduced Barriers



Figure 10 illustrates the level of interest among SMEs in future green financing opportunities if existing barriers are reduced, showing a strong willingness to adopt green finance under improved conditions.

The findings reveal a strong inclination among enterprises toward adopting green finance in the future if existing barriers are reduced. A majority of respondents (70%) expressed definite interest in future green financing opportunities. This suggests that reducing financial, institutional, and policy-related barriers could significantly enhance the adoption of green finance among SMEs.

Statistics

The internal consistency of the measurement scale was assessed through Cronbach's alpha.

Table-3 shows that the results indicate an acceptable level of reliability as the value of Cronbach's alpha is 0.797, which is acceptable, 0.7 (heir et al).

Cronbach's Alpha	N of Items
.797	24

Hypothesis Testing:

- H1. The perceived barriers to green finance significantly differ across types of industry

Table 4: Type of Industry

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Financial Barriers	Between Groups	1.054	2	.527	1.385	.256
	Within Groups	33.090	87	.380		
	Total	34.144	89			
Institutional Barriers	Between Groups	.421	2	.210	.660	.519
	Within Groups	27.706	87	.318		
	Total	28.126	89			
Policy and Regulatory Barriers	Between Groups	.599	2	.300	.806	.450
	Within Groups	32.361	87	.372		
	Total	32.960	89			

Table 4 presents the results of one-way ANOVA examining differences in perceptions of green finance barriers across different types of industries. The findings indicate that there are no statistically significant differences in perceptions of financial barriers ($F = 1.385$, $p = 0.256$), institutional barriers ($F = 0.660$, $p = 0.519$), and policy and regulatory barriers ($F = 0.806$, $p = 0.450$) among the industry groups. This suggests that SMEs across different industries perceive barriers to green finance adoption in a similar manner.

Hypothesis Testing:

- H2(a). Enterprise size has a significant effect on financial barriers to green finance.
- H2(b). Enterprise size has a significant effect on Institutional barriers to green finance.
- H2(c). Enterprise size has a significant effect on Policy and Regulatory barriers to green finance.

Table 5: Size of Enterprise

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Financial Barriers	Between Groups	.015	1	.015	.039	.844
	Within Groups	34.129	88	.388		
	Total	34.144	89			
Institutional Barriers	Between Groups	.283	1	.283	.895	.347
	Within Groups	27.843	88	.316		
	Total	28.126	89			
Policy and	Between Groups	.236	1	.236	.634	.428

Regulatory Barriers	Within Groups	32.724	88	.372		
	Total	32.960	89			

Table 5 presents the results of one-way ANOVA examining differences in perceptions of green finance barriers based on the size of the enterprise. The results reveal no statistically significant differences in financial barriers ($F = 0.039$, $p = 0.844$), institutional barriers ($F = 0.895$, $p = 0.347$), and policy and regulatory barriers ($F = 0.634$, $p = 0.428$) across different enterprise sizes, indicating uniform perceptions among SMEs

Hypothesis Testing:

- H3.Years of operation are significantly associated with perceived financial barriers.

Table 6: Years of Operation

ANOVA		Sum of Squares	df	Mean Square	F	Sig.
Financial Barriers	Between Groups	1.544	3	.515	1.358	.261
	Within Groups	32.600	86	.379		
	Total	34.144	89			
Institutional Barriers	Between Groups	.331	3	.110	.341	.796
	Within Groups	27.795	86	.323		
	Total	28.126	89			
Policy and Regulatory Barriers	Between Groups	1.431	3	.477	1.301	.279
	Within Groups	31.529	86	.367		
	Total	32.960	89			

Table 6 presents the results of one-way ANOVA examining differences in perceptions of green finance barriers based on the years of operation of SMEs. The results indicate that there are no statistically significant differences in financial barriers ($F = 1.358$, $p = 0.261$), institutional barriers ($F = 0.341$, $p = 0.796$), and policy and regulatory barriers ($F = 1.301$, $p = 0.279$) across different years of operation. This suggests that SMEs, irrespective of their operational experience, do not have any impact on their perception related to green finance barriers.

Explanatory Factor Analysis

Table 7: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			.888
Bartlett's Test of Sphericity	Approx. Chi-Square	df	729.368
		df	105
		Sig.	.000

As shown in Table 7, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.888, indicating excellent adequacy for factor analysis. Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 729.368$, $df = 105$, $p < 0.001$), confirming the suitability of the data for Exploratory Factor Analysis.

Table 8: Principal Component Analysis Matrix

Factor Name	Eigen Value	Variance Explained	Item Converged	Factor Loads
Policy and Regulatory Barriers	7.421	79.474	Policy implementation related to green finance is inconsistent across different states.	.744
			Information about available government schemes and financial incentives for green projects is inadequately communicated to stakeholders.	.701

			Complex documentation requirements and lengthy approval procedures discourage financing of green projects by banks.	.698
			Insufficient coordination between government agencies and banking institutions affects the effective implementation of green finance initiatives.	.652
			Lengthy and complicated regulatory procedures delay the approval and execution of green projects.	.636
			There is a lack of effective monitoring and accountability mechanisms for green finance initiatives.	.548
			There is a lack of adequate knowledge among bank officials in India regarding the appraisal of green projects.	.471
Institutional Barriers	1.122	7.479	The absence of specialised intermediaries (such as Energy Service Companies or green finance consultants) acts as a barrier to the adoption of green technologies.	.773
			There is a lack of clear government guidelines or standardised criteria for identifying and approving green projects.	.759
			Inadequate institutional support mechanisms and limited training programs constrain the development of green finance in India.	.696
			There is limited awareness of available green finance schemes among potential adopters.	.641
Financial Barrier	1.029	6.859	Lenders perceive green technology investments as high financial risk.	.772
			The high initial cost of adopting green technologies is a significant barrier.	.748
			Difficulty in accessing affordable long-term credit hinders the adoption of green technologies.	.714
			Lack of collateral or adequate financial security limits access to financing for green initiatives.	.487

The results of the Principal Component Analysis reveal the extraction of three significant factors influencing barriers to green finance adoption among SMEs. The first factor, Policy and Regulatory Barriers, explains the highest variance (79.474%) with strong factor loadings across related items. The second factor, Institutional Barriers, accounts for (7.479%) of the variance, highlighting the role of institutional support and intermediaries. The third factor, Financial Barriers, explains (6.859%) of the variance, reflecting cost, risk, and credit-related constraints. All retained factors have eigenvalues greater than one, indicating their statistical significance. Overall, the factor structure confirms the validity of the identified dimensions of green finance barriers.

Explanation for PCA Matrix

Principal Component Analysis (PCA) was conducted to identify the underlying dimensions influencing barriers to green finance adoption among small and medium enterprises (SMEs). The analysis extracted three factors with eigenvalues greater than 1, explaining a substantial proportion of the total variance.

The first factor, labelled Policy and Regulatory Barriers, recorded the highest eigenvalue 7.421 and explained 79.474% of the total variance. This factor comprised items related to inconsistent policy implementation across states, inadequate communication of government schemes and incentives, complex documentation and approval procedures, insufficient coordination between government agencies and banks, lengthy regulatory processes, lack of monitoring and accountability mechanisms, and limited knowledge among bank officials. The factor loadings for these items ranged from 0.471 to 0.744, indicating a strong convergence of policy- and regulation-related issues.

The second factor, termed Institutional Barriers, had an eigenvalue of 1.122 and explained 7.479% of the total variance. This factor included items associated with the absence of specialised intermediaries, lack of clear government guidelines, inadequate institutional support and training programs, and limited awareness of green finance schemes. Factor loadings ranged from 0.641 to 0.773, reflecting a satisfactory level of item convergence.

The third factor, identified as Financial Barriers, recorded an eigenvalue of 1.029 and accounted for 6.859% of the total variance. This factor comprised items relating to perceived high financial risk by lenders, high initial cost of adopting green technologies, difficulty in accessing affordable long-term credit, and lack of collateral or financial security. Factor loadings ranged from 0.487 to 0.772, indicating moderate to strong associations between the items and the factor.

Overall, the PCA results demonstrate that the extracted factors are conceptually meaningful and

statistically sound, collectively explaining a significant proportion of variance in barriers to green finance adoption among SMEs. The factor structure supports the construct validity of the measurement scale and provides a clear framework for further analysis.

Discussion

The current study examined the key impediments affecting the adoption of green finance among Indian SMEs and assessed whether these impediments vary across enterprise characteristics. The findings read strongly empirical hold for the study's objectives and are mainly consistent with existing evidence on green finance adoption in emerging economies.

The measurement instrument's robustness is confirmed by reliability and validity results. By meeting established benchmarks for social science research, the Cronbach's alpha value of 0.797 indicates acceptable internal consistency (Hair et al., 2019). The statistically significant Bartlett's Test of Sphericity and the Kaiser-Meyer-Olkin (KMO) value of 0.888 further validate the suitability of the data for factor analysis and aid the extraction of meaningful underlying dimensions.

In shaping green finance adoption among SMEs, policy and regulatory, institutional, and financial are three dominant barriers identified by Exploratory factor analysis. Policy and regulatory impediments elucidate the highest proportion of variance, underscoring their central role. Critical constraints that have emerged are inconsistent policy implementation, complex approval processes, limited dissemination of government schemes, and weak coordination between regulatory bodies and financial institutions. The major impediments of SME participation in green finance initiatives in India are regulatory uncertainty and procedural complexity, which are reinforced by earlier studies (Bharati & Patra, 2022; Chandran et al., 2025).

Institutional barriers, and other which significantly influence adoption include the lack of specialised intermediaries, limited training opportunities, and insufficient technical advisory support. For improving SMEs' ability to access and utilise green financial instruments effectively, institutional capacity and knowledge support are essential, as emphasised by this and prior research (Chandrayanti et al., 2023). High upfront costs, perceived investment risks, and limited access to long-term credit are some financial barriers that remain influential. Lender risk perceptions continue to restrict green lending in emerging markets (Mirza et al., 2023).

The descriptive findings further complement these results. There are persistent financial constraints, information asymmetries, and cautious lending faced by SMEs for bank loans or external financing for green projects; such patterns are also noted in many

of the earlier empirical studies (Bharati & Patra, 2022; OECD, 2021). There is a strong inclination toward policy-backed, low-risk financial support as the respondents show a clear preference for subsidised loans, tax incentives, and grants over equity-based or market-driven financing mechanism (Bharati & Patra, 2022; Pradhan & Venkat Krishna, 2024).

Many gaps in technical knowledge and advisory capacity spotlight moderate confidence levels in evaluating green technologies. Adoption lacks despite positive intent, as studies reported that inadequate expertise limits SMEs ability to assess costs, performance, and long-term benefits of green investments (Bharati & Patra, 2022; Chandrayanti et al., 2023). Training programs, workshops, and government-supported technical advisory services are some strong preferences of SMEs', which earlier research lightened as vital enablers of effective green finance utilization (Chandrayanti et al., 2023; Bharati & Patra, 2022).

Communication and coordination gaps are suggested and partial or uncertain awareness persists as reported by respondents about awareness of government schemes promoting green finance. The effectiveness of green finance policies is reduced due to fragmented dissemination and weak institutional linkages, resulting in underutilization despite nominal awareness (Jaura, 2023; Bharati & Patra, 2022). An observation which is consistent with earlier policy-oriented research, that emphasised simplified eligibility criteria and enhanced incentives over mandatory regulatory measures, reflecting a preference for facilitative rather than coercive policy approaches (Bharati & Patra, 2022; Chandran et al., 2025).

Policy and institutional shortcomings outweigh profitability concerns, primary reasons for non-adoption are the absence of incentives, limited awareness, and technical constraints. These findings are in synergy with previous studies too which suggests that return expectations comes second and first is information and capacity barriers (Bharati & Patra, 2022; Jaura, 2023). Though adoption remains constrained, SMEs recognizes the strategic importance of green finance for long-term sustainability, resilience, and alignment with climate goals (Mishra & Kannaujia, 2023; Mirza et al., 2023).

To conclude, there is high level of interest in future green financing with reduced barriers, this is substantial latent demand. With following improvements such as regulatory clarity, risk mitigation mechanisms, and institutional support – green finance adoption among SMEs could impulse significantly, as underscored by researchers (Pradhan & Venkat Krishna, 2024; Raman et al., 2025).

The Indian context is that green finance barriers are systemic and not firm-specific, due to the absence of significant differences across industry type,

enterprise size, and years of operation.

By addressing these interconnected policy, institutional, and financial constraints through comprehensive reforms, it is crucial to enable SMEs to play a more effective role in India's sustainable development and climate.

Conclusion

The study spotlights two areas: firstly, the barriers influencing the adoption of green financial initiatives among Indian SMEs, and secondly, to assess whether perceptions of these barriers differ across enterprise characteristics. With clear and objective conclusions, this study contributes noteworthy empirical insights to the green finance literature.

With respect to the first objective, the study encounters policy and regulatory barriers as the most vital constraints affecting SMEs' adoption of green finance. Effective participation is restricted by inconsistent policy implementation, limited dissemination of government schemes, complex approval procedures, and weak coordination between regulatory bodies and financial institutions. SMEs' capacity to evaluate and utilise green financial instruments is constrained by institutional barriers such as inadequate technical advisory services, limited training opportunities, and the absence of specialised intermediaries. High initial investment costs, perceived risks, and restricted access to long-term credit are some financial barriers that remain influential, though they are secondary to policy and institutional limitations. As a result, systemic Constraints rather than firm-level unwillingness primarily hinder green finance adoption among SMEs, which also reinforces existing research.

In relation to the second objective, across SME characteristics such as firm size, industry type, or years of operation the study finds no statistically significant variation. This suggests that green finance challenges are structural in nature and uniform across the SME sector. Similar difficulties i.e. regulatory complexity, institutional support, and financial accessibility, are reported consistently by SMEs, regardless of the enterprise profile. Highlighting the need for sector-wide policy and institutional reforms rather than narrowly targeted interventions, the findings suggest that individual firm attributes do not substantially alter perceptions of green finance barriers.

There is strong awareness of the long-term sustainability benefits of green finance among Indian SMEs and express considerable interest in future adoption. Some impediments for effective implementation are systemic policy, institutional and financial barriers. To unlock SMEs' potential contribution to India's sustainable development and climate transition, it is essential that constraints should be addressed through simplified regulatory frameworks, strengthened institutional support

mechanisms, and enhanced risk-mitigation and incentive structures.

Implication

The study offers key research, financial, policy, managerial and institutional implications for boosting green finance acceptance in Indian SMEs.

- **Research implications:** The uniform perception of barriers across SME characteristics advocates that future research should spotlight on system-level policy and institutional factors. Moreover, longitudinal and cross-country studies could inform effective SME-oriented green finance frameworks.
- **Financial implications:** SMEs' preference for subsidised credit, grants, and guarantees infers the need for concessional financing, risk-sharing mechanisms, and blended finance models to level-down perceived risks and improve access to long-term capital.
- **Policy implications:** The prominence of policy and regulatory barriers highlights the need for simplified approval processes, improved inter-agency coordination, and consistent follow-up of green finance policies. Strengthening targeted communication and outreach mechanisms can help convert scheme awareness into effective participation.
- **Managerial implications:** While SMEs recognise the long-term value of green finance, limited technical and financial confidence constrains adoption. Enhancing managerial skills through training, advisory support, and strategic partnerships can facilitate informed green investment decisions.
- **Institutional implications:** Institutional constraints highlight the significance of expanding training, advisory services, and capacity-building initiatives. The development of specialised green finance intermediaries can enhance SMEs' ability to evaluate green technologies and access appropriate financial instruments.

All in all, the findings stress that coordinated reforms across policy, institutional, financial, and enterprise levels are a must for speedy green finance adoption and support sustainable development.

Limitation Of The Study

There are some checks despite its contributions. Firstly, the ability to capture changes in green finance adoption and perception over time is restricted because the analysis is based on cross-sectional data. Longitudinal studies could provide deeper insights into how policy and institutional reforms affect SME behaviour. Second, the study relies on self-reported responses, which may be subject to respondent bias

or perceptual inaccuracies. Thirdly, the generalizability of the findings to other national or economic contexts is constrained because the sample is limited to Indian SMEs. To conclude, the study does not assess the effectiveness of specific policy instruments or financial products; it identifies key barriers to green finance adoption, suggesting scope for more targeted future research.

Future Scope Of The Study

Changes in policy frameworks, institutional support, and financial instruments which influences green finance adoption among SMEs over time can be examined by adopting longitudinal designs in future research. Deeper insights into industry-level variations in barriers and adoption patterns using sector-specific analyses. The effectiveness of specific green financial products, incentives, and risk-mitigation mechanisms in improving SME participation could be evaluated in further studies. Transferable policy lessons and best practices could be identified by involving in comparative research across emerging economies. Moreover, the understanding of implementation challenges and institutional dynamics shaping green finance adoption could be enriched by incorporating qualitative approaches such as interviews with policymakers, financial institutions, and SME owners.

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