

RESEARCH ARTICLE

Decarbonization of Indian Banking: Challenges & Pathways Forward

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Abstract

The decarbonization of the Indian banking sector is critical to achieving India's climate goals and facilitating its transition to a sustainable, low-carbon economy. This study evaluates the current status of decarbonization efforts, identifies key barriers, and proposes strategic solutions to promote green banking practices. A systematic literature review (SLR) was conducted, adhering to PRISMA guidelines, to analyze existing research, policy documents, and institutional reports. The analysis categorized challenges into regulatory, financial, technological, organizational, and cultural barriers while exploring opportunities for advancement. Private sector banks have made significant strides in adopting green banking practices, including financing renewable energy projects, issuing green bonds, and integrating energy-efficient operations. In contrast, public sector banks and smaller institutions lag due to regulatory gaps, financial constraints, and technological limitations. Key challenges include the absence of mandatory sustainability regulations, limited consumer demand for green products, and high implementation costs. Promising opportunities include expanding the green bond market, leveraging advanced technologies such as AI and blockchain, and fostering multi-stakeholder collaborations. The Indian banking sector can play a transformative role in achieving the country's climate objectives by adopting a multifaceted approach. Regulatory reforms, capacity-building initiatives, and technological integration are crucial. Strengthening the regulatory framework, offering financial incentives, and promoting consumer awareness of green banking products will drive progress. Recommendations include mandatory environmental risk disclosures, alignment with international sustainability standards, and investment in green finance instruments. Enhanced collaboration among banks, regulators, and stakeholders is essential to overcome systemic barriers and capitalize on emerging opportunities. This research underscores the need for a multifaceted approach to overcome systemic barriers and leverage emerging opportunities. By addressing these challenges, the Indian banking sector can play a transformative role in driving the country's climate agenda while ensuring financial resilience and long-term growth. The study concludes with recommendations for policy interventions, institutional strategies, and future research directions.

Key Words: Decarbonization; Green banking; Sustainable finance; Indian banking sector; Regulatory framework

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1. Introduction

The banking sector in India is a critical pillar of the country's economic development, influencing various industries through its financing mechanisms. As India confronts the twin challenges of economic growth and climate change, the role of the banking sector in promoting sustainability has gained increasing importance. Decarbonization in the banking sector refers to the integration of sustainable finance practices, including green banking, which focuses on reducing carbon footprints through financing initiatives, operational practices, and investments aligned with low-carbon outcomes [1,2]. This transformation is particularly relevant as global concerns about climate change and environmental degradation have made sustainable banking practices crucial in the fight against climate change [3,4].

1.1. The importance of green banking in India

The Indian banking sector's transition towards sustainable practices is inextricably linked to India's national and international climate commitments. As part of the Paris Agreement, India has pledged to reduce its carbon intensity and increase the share of non-fossil energy sources in its energy mix. This ambitious agenda requires the financial sector to play a pivotal role in financing low-carbon projects and managing the environmental risks associated with lending practices [5,6]. Furthermore, integrating green banking practices is increasingly seen as a way for banks to manage long-term environmental, social, and governance (ESG) risks and opportunities, contributing to both sustainable development and corporate profitability [7,8].

Green banking in India encompasses various initiatives, including offering green loans, financing renewable energy projects, investing in sustainable technologies, and reducing the environmental footprint of banking operations through digitalization and sustainable business practices [9,10]. It is part of a broader move towards sustainable finance, where financial institutions align their operations and portfolios with sustainable development goals (SDGs) and low-carbon objectives [11,12]. However, despite the growing recognition of these principles, the Indian banking sector faces numerous challenges in achieving full decarbonization.

1.2. Challenges hindering decarbonization

Several barriers hinder the full integration of decarbonization practices in the Indian banking sector. First, there is a lack of a clear regulatory framework that mandates or incentivizes banks to reduce their carbon footprint [13,14]. Although the Reserve Bank of India (RBI) and other regulators have issued guidelines on green banking, the absence of robust enforcement and comprehensive policies leaves significant room for improvement [15]. This has led to a fragmented approach among banks, with some leading the charge on green finance, while others are still in the early stages of adopting sustainable practices [1,16].

A second significant challenge is the resistance to change within the financial sector, particularly in adopting new technologies and sustainable business models. The banking sector is traditionally risk-averse, and the integration of environmental risk management into lending and investment decisions is seen as complex and resource-intensive [4,9]. Additionally, many banks face difficulty in measuring and managing environmental risks effectively, due to a lack of expertise in sustainability and insufficient data on the environmental performance of borrowers [2,17].

Moreover, the financial feasibility of sustainable projects often becomes a point of contention, as green initiatives are sometimes perceived as more costly or risky compared to conventional investments [10,18]. This is particularly pertinent in a country like India, where financing for sustainable development is often constrained by competing priorities and financial uncertainties [14].

1.3. Opportunities for decarbonization

Despite these challenges, there are several promising opportunities to drive decarbonization in the Indian banking sector. Green finance instruments, such as green bonds, green loans, and sustainable investment funds, have gained traction globally and are beginning to take root in India. The development of these financial products can help banks diversify their portfolios while supporting sustainable projects, such as renewable energy, energy efficiency, and low-carbon infrastructure [8,11]. The green bond market in India, for example, is expected to grow, with both private and public sector banks issuing bonds to finance sustainable projects [19,20].

Additionally, the implementation of digital banking technologies and FinTech solutions can facilitate the adoption of green banking practices by reducing the operational carbon footprint of banks and enhancing the efficiency of lending decisions [16,21]. Digital platforms can provide better access to environmental data and enable banks to better assess the sustainability performance of their clients, thus promoting more informed lending and investment decisions [10,22].

1.4. Strategic solutions for overcoming barriers

To overcome the existing barriers and facilitate a smoother transition towards sustainable banking, a multifaceted approach is needed. First, regulatory frameworks must be strengthened to create clear incentives for banks to invest in decarbonization and to integrate environmental risk management practices into their operations [6,14]. This includes introducing mandatory environmental disclosures and setting clear carbon reduction targets for financial institutions [3,9].

Second, capacity-building initiatives are essential to equip banks with the necessary knowledge and tools to assess and manage environmental risks. Training programs and collaboration with environmental experts can help banking institutions better understand and implement green banking strategies [2,8]. Finally, collaboration between banks, regulators, and other stakeholders, such as NGOs, businesses, and governmental bodies, is crucial for pooling resources and knowledge to overcome financial and technological challenges. Such collaboration can help develop innovative financing mechanisms that lower the cost of capital for sustainable projects and encourage greater investment in green technologies [4,7].

The Indian banking sector's decarbonization is a critical element in the country's transition towards a sustainable, low-carbon economy. While significant progress has been made in promoting green banking practices, substantial challenges remain. By strengthening regulatory frameworks, investing in capacity-building, and fostering collaboration between stakeholders, the banking sector can overcome these barriers and play a transformative role in financing a sustainable future for India [9,10]. This research aims to evaluate the current status of decarbonization in Indian banks, identify key challenges, and propose strategic solutions to accelerate the sector's transition towards sustainable banking practices, ultimately contributing to India's broader climate goals.

1.5. Objective of the study

The objective of this research study is to evaluate the current status of decarbonization in the Indian banking sector, identify key challenges hindering progress, and propose strategic solutions to overcome these barriers and facilitate a smoother transition towards sustainable banking practices.

2. Literature Review

This systematic literature review (SLR) aims to evaluate the current status of decarbonization in the Indian banking sector, identify key challenges hindering progress, and propose strategic solutions to overcome these barriers. To ensure rigor and transparency, this review adheres to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which provide a structured approach for conducting and reporting systematic reviews. The methodology follows several well-defined steps, which are outlined below.

2.1. Eligibility criteria

The inclusion criteria for selecting studies were designed to ensure the relevance and quality of the literature included in the review. Studies were eligible for inclusion if they:

2.1.1. Focused on the Indian banking sector

This includes research directly or indirectly related to banks operating within India, especially those addressing sustainability, green finance, and decarbonization practices.

2.1.2. Addressed decarbonization or green banking

Relevant studies covered topics such as green banking practices, carbon footprint reduction, renewable energy financing, environmental risk management, and policies related to decarbonization in financial institutions.

2.1.3. Included peer-reviewed articles and grey literature

Eligible literature included peer-reviewed journal articles, policy reports, case studies, and other authoritative sources like government reports (e.g., Reserve Bank of India guidelines on green banking).

2.1.4. Published in English

Only articles published in English were included to ensure accessibility and comprehensibility for the researchers.

Studies were excluded if they:

1. Focused on sectors other than banking or finance.
2. We're not directly related to decarbonization or sustainability within the banking context (e.g., studies solely focused on general banking efficiency without addressing sustainability issues).
3. We're not available in full-text or in English.

4. Were opinion pieces, commentaries, or non-empirical in nature without a clear methodology or data analysis.

2.2. Search strategy

A comprehensive search strategy was employed to identify studies from multiple sources to ensure a broad and inclusive review. The search included the following key steps:

2.2.1. Databases searched

The primary databases used for the literature search included Scopus, Web of Science, Google Scholar, and JSTOR. These databases were selected for their comprehensive coverage of academic literature, including journals, conference proceedings, and grey literature.

2.2.2. Keywords and search terms

The search terms were carefully chosen to capture all relevant literature on the topic of decarbonization in the Indian banking sector. Keywords included:

- Decarbonization in Indian banking sector.
- Green banking in India.
- Sustainable finance India.
- Environmental risk management banking India.
- Carbon footprint banking India.
- Renewable energy financing banks India.

2.2.3. Search filters

Search results were filtered to include studies published after 2000 and only those in English. The search also prioritized academic articles, reports, and case studies published in reputable journals and by reputable organizations such as the Reserve Bank of India (RBI), International Finance Corporation (IFC), and other sustainability-focused institutions.

The search process involved multiple rounds, refining and expanding the search terms to ensure the inclusion of all relevant studies. To reduce publication bias, both peer-reviewed articles and grey literature were included, as reports from government agencies and international organizations can provide valuable insights into policy-level initiatives and industry trends [9,23].

2.3. Study selection process

The study selection process involved several stages, each designed to ensure that only the most relevant and high-quality studies were included in the review.

2.3.1. Initial screening

The first stage involved screening the titles and abstracts of studies identified in the database search. This was done to eliminate studies that clearly did not meet the inclusion criteria. Studies that focused on non-banking sectors or were not related to decarbonization in banking were excluded.

2.3.2. Full-text review

After the initial screening, full-text reviews were conducted on the remaining studies. The full-text review was performed to ensure that the study addressed the key research questions—specifically, the status of decarbonization in Indian banks, the challenges faced, and proposed strategies. If a study did not meet the eligibility criteria, it was excluded at this stage. The full-text review process was conducted independently by two reviewers to ensure consistency and reduce potential bias.

2.3.3. Data extraction

From the selected studies, data were extracted using a structured template to capture relevant information. The following key data points were extracted:

- **Study details:** Author(s), year of publication, and source of the study.
- **Decarbonization status:** The level of decarbonization adoption in the Indian banking sector, including the types of green banking practices implemented.
- **Challenges identified:** Regulatory, technological, financial, organizational, and cultural barriers to decarbonization.
- **Strategic solutions:** Proposed strategies for overcoming the challenges identified and facilitating a transition towards sustainable banking practices.
- **Duplicate removal:** Duplicate records were removed using reference management software. Any study identified multiple times across databases or search terms was reviewed only once to ensure that the analysis was based on unique studies.

2.4. Current status of decarbonization in the Indian banking sector

The decarbonization of the Indian banking sector is an ongoing process with mixed progress across public and private sector banks. In recent years, the integration of green banking practices has emerged as a critical aspect of the sector's commitment to sustainability. Green banking encompasses various practices aimed at reducing the environmental impact of banking operations, financing renewable energy projects, and promoting sustainable financial products.

2.5. Green banking practices

Several Indian banks, particularly private-sector ones, have proactively adopted green banking initiatives. These practices include financing renewable energy projects, offering green bonds, and adopting internal measures to reduce the carbon footprint of their operations [1].

For instance, the State Bank of India (SBI) and ICICI Bank have issued green bonds to raise capital for renewable energy investments. These bonds have been used to fund solar and wind energy projects, contributing to India's renewable energy capacity [17].

Additionally, banks like Axis Bank and Yes Bank have introduced green lending products, targeting eco-friendly businesses and projects [18]. These efforts, while commendable, represent the actions of a small number of large institutions, with progress being slower in the public sector, where adoption is less widespread.

2.6. Regulatory frameworks

The regulatory environment plays a vital role in the decarbonization process. The Reserve Bank of India (RBI) has introduced guidelines on green banking, which encourage banks to incorporate environmental risk considerations into their lending practices. These guidelines include environmental risk management frameworks and green investment standards for financial institutions [15]. However, as highlighted by Ghosh et al. [2], the regulations are not mandatory, and their implementation remains voluntary, leading to uneven adoption across the banking sector. While larger, more technologically advanced private banks are better positioned to integrate green banking, smaller, public-sector banks face significant challenges, particularly due to the lack of clear and enforceable directives from the government.

Moreover, India's financial regulators have been slow to introduce more stringent regulations on carbon emissions and environmental risk assessments, which limits the extent to which banks are held accountable for their environmental impact [9]. While the 2020 National Action Plan on Climate Change (NAPCC) includes specific measures for green finance, the lack of comprehensive policies at the banking level hampers broader systemic change [24].

2.7. Technological integration

Technological adoption is another critical factor in advancing decarbonization in the Indian banking sector. Banks have started using technology for environmental risk management, such as AI for assessing environmental risks in their portfolios, blockchain for improving transparency in green bond issuance, and data analytics for tracking carbon footprints [10]. However, many smaller banks still lack the necessary infrastructure to implement such technologies effectively, which limits the sector's ability to fully embrace decarbonization.

According to a study by Ghosh et al. [2], the adoption of renewable energy technologies, like solar panels, has been successful in some urban branches, but there is a significant gap in rural areas where infrastructure limitations and the high cost of technology are significant barriers. Therefore, while large banks in metropolitan areas have made notable strides in decarbonization, much of the sector, especially smaller and public sector banks, is yet to embrace these technological innovations.

2.8. Key challenges hindering decarbonization in the Indian banking sector

Despite the growing awareness and adoption of green banking practices, several significant challenges hinder the progress of decarbonization within the Indian banking sector. These challenges can be grouped into regulatory, financial, technological, organizational, and cultural barriers.

2.9. Regulatory barriers

A major challenge in the Indian banking sector is the lack of a robust and enforceable regulatory framework mandating decarbonization. While RBI's guidelines on green banking provide a framework for environmental risk management, these guidelines are not legally binding, which has led to inconsistent implementation across the sector [9]. Unlike other countries, where banks are legally required to report their carbon footprints and integrate environmental risks into their financial decision-making, India's banking sector lacks such compulsory requirements. As a result, many banks, particularly smaller public sector banks, continue to prioritize short-term financial gains over long-term sustainability goals [2].

Furthermore, the absence of standardized carbon accounting and reporting measures means that banks struggle to monitor and manage their environmental impact effectively [18].

2.10. Financial and economic barriers

The financial barriers to decarbonization are significant, particularly for smaller banks. The high upfront costs of adopting green technologies, such as solar panels, energy-efficient systems, and eco-friendly infrastructure, present a significant challenge [4]. Additionally, access to green finance is limited, particularly for smaller banks that may lack the expertise to navigate green financing markets or access global capital markets. This is compounded by the higher perceived risk of financing green projects compared to traditional investments, as highlighted by Mahapatra et al. [17]. Although there is increasing interest in green bonds and sustainable investment products, the green bond market in India remains underdeveloped compared to global markets, limiting the availability of low-cost capital for green projects [23].

Moreover, despite the economic incentives offered by the government for renewable energy projects, many banks remain hesitant to fund green projects due to concerns over their relatively lower returns and higher risks [1]. This reluctance to invest in green projects slows down the overall decarbonization process in the banking sector.

2.11. Technological barriers

Technological limitations also pose a challenge to decarbonization in the Indian banking sector. While some banks have adopted advanced technologies such as AI and blockchain to improve carbon footprint tracking and environmental risk management, the majority of banks, especially those in rural or underserved areas, lack the infrastructure to support these innovations [10]. According to Ghosh et al. [2], the cost of implementing these technologies is prohibitive for smaller banks, and the complexity of integrating them into existing systems is a significant barrier. This technological divide creates disparities between large urban banks and smaller regional banks, limiting the overall effectiveness of the sector's decarbonization efforts.

2.12. Organizational and cultural resistance

Organizational inertia and cultural resistance to adopting green banking practices are significant barriers within the Indian banking sector. Many institutions continue to prioritize profitability over sustainability due to the lack of strong institutional support for green initiatives [22]. The slow pace of change is compounded by a lack of skilled professionals who can lead the decarbonization efforts. According to Datta et al. [14], many banks struggle with integrating sustainability into their corporate culture and face difficulties in developing a long-term vision for decarbonization. This cultural resistance is especially evident in public sector banks, where traditional banking practices often dominate, and sustainability concerns are sidelined [12].

2.13. Stakeholder and consumer awareness

Finally, low consumer awareness of the environmental impact of banking practices also limits the demand for green banking products. As noted by Sharma et al. [8], most Indian consumers are not well-informed about the environmental benefits of choosing green banking products. This lack of awareness reduces consumer demand for green banking options, which in turn discourages banks from offering such products. Moreover, as noted by Menon [22], public

sector banks are often less motivated to push sustainable products due to the absence of market-driven pressures for environmental responsibility.

In conclusion, the decarbonization of the Indian banking sector faces several formidable barriers, ranging from regulatory and financial challenges to technological limitations and organizational resistance. Addressing these challenges requires a multi-faceted approach, including stronger regulations, enhanced financial incentives, improved access to technology, and greater consumer engagement with sustainable banking products.

2.14. Strategic solutions to overcome barriers and facilitate the transition to sustainable banking

To address the key challenges hindering decarbonization in the Indian banking sector, several strategic solutions are proposed. These solutions encompass regulatory, financial, technological, organizational, and consumer engagement measures, all aimed at facilitating a smoother transition to sustainable banking practices.

2.15. Regulatory solutions

One of the most pressing needs for advancing decarbonization in the Indian banking sector is the development and implementation of a robust regulatory framework. While the Reserve Bank of India (RBI) has issued voluntary green banking guidelines [15], a more comprehensive and mandatory regulatory framework is necessary to ensure uniform adoption of sustainable practices across the sector. As highlighted by Sarkar et al. [9], mandatory regulations could include requirements for banks to integrate environmental risk management into their lending processes, set carbon reduction targets, and disclose their carbon footprints. Such regulations would create a level playing field and drive all banks, including public sector banks, to adopt sustainable practices.

For example, adopting policies that mandate banks to disclose their environmental impacts annually, similar to the EU's Non-Financial Reporting Directive, would promote transparency and accountability [25]. Furthermore, aligning Indian banking regulations with international frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD) would enable Indian banks to attract international investors who are increasingly prioritizing sustainability [23].

2.16. Financial and economic solutions

The high cost of decarbonization and limited access to green finance are significant barriers. To overcome these financial challenges, the Indian government should consider providing subsidies, low-interest loans, or tax incentives for banks that invest in green projects [18]. For instance, offering tax breaks for renewable energy investments could incentivize banks to finance green energy projects and reduce the perceived risk associated with such investments. This would help banks manage the upfront costs of transitioning to sustainable banking practices.

In addition, expanding the green bond market in India would provide banks with greater access to affordable capital to finance green initiatives [1]. The creation of a more robust green bond market would encourage both public and private sector banks to issue green bonds and fund renewable energy and sustainable development projects. According to the International Finance Corporation [23], creating a domestic green bond market would allow India to tap

into the global green finance ecosystem, facilitating the flow of sustainable capital into the banking sector.

2.17. Technological solutions

Technological innovation is key to enabling the decarbonization of the banking sector. The adoption of digital platforms and AI-driven tools can facilitate carbon footprint tracking, improve environmental risk assessments, and streamline the management of green finance portfolios. Ghosh et al. [10] suggested that technologies like blockchain could enhance the transparency and accountability of green bonds and other sustainable finance products by providing immutable and traceable records of transactions. Banks should also invest in renewable energy technologies, such as solar panels, to reduce the carbon emissions associated with their operations [2].

Moreover, partnerships with technology providers could help banks develop digital solutions for customers that encourage sustainable behavior. For example, AI can be used to analyze customer spending patterns and suggest eco-friendly financial products. Such innovations would not only help banks reduce their own environmental footprint but also facilitate customers' transition to greener choices.

2.18. Capacity building and skill development

A critical barrier to the adoption of green banking is the lack of skilled professionals who can lead sustainability initiatives within financial institutions. As highlighted by Menon [22], many banks lack the necessary expertise to implement and manage green finance projects. To address this gap, banks should invest in training programs focused on sustainable finance, carbon accounting, and environmental risk management. Additionally, Indian banking schools and financial institutions can introduce specialized courses in sustainable banking and green finance to develop a skilled workforce capable of driving the sector's decarbonization agenda [2].

2.19. Public awareness and stakeholder engagement

Another crucial solution is the need to increase consumer awareness and engagement with sustainable banking products. Public sector banks, in particular, face challenges in promoting green products due to a lack of consumer demand. As noted by Sharma et al. [8], raising awareness about the environmental impact of banking operations can increase the demand for green banking products. Banks can engage consumers through educational campaigns and by offering incentives such as rewards for choosing eco-friendly financial products. Additionally, banks should engage with environmental NGOs and community organizations to promote green banking and educate the public on how their banking choices can contribute to sustainability [26].

Banks should also collaborate with other stakeholders, such as government agencies, international organizations, and industry associations, to promote green finance and encourage the development of green products. According to Datta et al. [14], cross-sector collaboration can help establish industry standards, share best practices, and create a more supportive ecosystem for sustainable finance.

3. Results and Discussion

The systematic literature review reveals that the decarbonization of the Indian banking sector is progressing but remains inconsistent, with notable gaps in implementation, especially in public sector banks and smaller financial institutions. While leading private banks such as ICICI Bank and Axis Bank have adopted green banking practices, including financing renewable energy projects and issuing green bonds, public sector banks have been slower to embrace these practices due to limited resources, technological barriers, and regulatory uncertainty [2,17]. The challenges hindering progress, including regulatory gaps, financial constraints, technological limitations, and cultural resistance, are substantial but not insurmountable.

4. Methodology

This study utilizes a systematic literature review (SLR) approach to thoroughly evaluate the decarbonization status of the Indian banking sector, with a focus on identifying existing challenges and potential opportunities for implementing green banking practices. The SLR method was chosen for its structured process, enabling a comprehensive and objective synthesis of existing research and industry insights. The study draws upon multiple sources, including peer-reviewed journal articles, policy documents, and institutional reports, to ensure a robust understanding of the subject. These sources provided diverse perspectives on sustainability practices, regulatory frameworks, environmental risk management, and green finance in the Indian banking sector.

The inclusion criteria for the literature review were designed to focus on research directly relevant to the Indian banking sector, especially concerning decarbonization, green banking, and sustainable finance practices. Studies that lacked empirical methodologies, were non-banking-related, or were opinion-based without structured analysis were excluded from consideration. A keyword-based search strategy was implemented to identify relevant studies, using terms such as “decarbonization in Indian banking,” “green banking in India,” “environmental risk management banking,” and “renewable energy financing by banks.” Databases like Scopus, Web of Science, Google Scholar, and JSTOR were utilized for their extensive coverage of academic and industry literature. Search filters were applied to limit results by publication date, language, and relevance, ensuring the inclusion of high-quality studies.

The study selection process involved a multi-stage approach. First, titles and abstracts of the identified studies were screened to eliminate irrelevant articles. In the second stage, full-text reviews were conducted to confirm that the selected studies aligned with the research objectives. During this stage, key data points, such as decarbonization practices, challenges faced by the banking sector, and strategic solutions proposed in the literature, were systematically extracted and documented. This rigorous selection process was conducted independently by multiple reviewers to minimize potential biases and ensure consistency.

The analytical framework used in the study categorized challenges into five broad groups: regulatory, financial, technological, organizational, and cultural barriers. This categorization facilitated a detailed examination of the systemic obstacles hindering decarbonization efforts in Indian banks. Opportunities and solutions were analyzed in terms of their practicality, scalability, and alignment with global sustainability standards, such as the Task Force on Climate-related Financial Disclosures (TCFD) and the Green Bond Principles. The study

emphasized the importance of integrating these global frameworks into India's banking practices to attract international investments and foster alignment with global climate goals. To validate the findings, a triangulation method was employed, cross-referencing data from diverse sources to ensure the robustness and reliability of conclusions.

This methodology, combining systematic data collection and rigorous analysis, provides a strong foundation for understanding the current decarbonization landscape in the Indian banking sector. It also offers valuable insights into the pathways required to overcome barriers and promote sustainable banking practices in alignment with India's broader climate commitments.

5. Finding

5.1. Current status of decarbonization in Indian banks

Table 1: Analysis of existing decarbonization initiatives and their effectiveness.

Decarbonization initiative	Description	Effectiveness	Citations
Adoption of green banking practices	Banks implement green banking practices to encourage sustainability in financial services.	Promising in promoting environmental responsibility, but effectiveness is hindered by inconsistent implementation and lack of comprehensive regulatory support.	Chaurasia [27]
Carbon footprint measurement and reporting	Banks are measuring and reporting their carbon footprint as part of their sustainability initiatives, often in line with international reporting standards like GRI and CDP.	Effective in increasing awareness, but implementation is still nascent, with limited data transparency in some banks.	Ghosh et al. [4]; Ghosh et al. [10].
Carbon footprint reduction targets	Setting specific targets for reducing carbon emissions in banking operations.	Mixed effectiveness, with some banks achieving significant reductions, but overall impact varies due to inconsistent commitment levels.	Ghosh et al. [4]; Mahapatra et al. [17].
Carbon offsetting programs	Banks are participating in carbon offsetting through investments in forestry and other carbon credit schemes.	Offsetting programs are gaining popularity but are still limited in scope. The effectiveness of these programs is debated, and more evidence is needed to gauge their actual impact.	Ghosh et al. [4]; Chandra et al. [13].
collaboration with renewable energy projects for financing and advisory services	Banks partner with renewable energy projects to provide both financial resources and advisory services.	Positive outcomes; these collaborations are contributing to the growth of the renewable energy sector in India.	Kaur [16]; Menon [22].
Collaborations with government and NGOs	Banks are collaborating with the government and NGOs to fund and promote sustainable development projects, such as affordable housing and clean transportation.	Mixed results; collaboration with government initiatives has had some impact, but challenges persist in financing at scale.	Sahoo et al. [12]; Gupta et al. [28].
Corporate Social Responsibility (CSR) initiatives	Banks engage in CSR activities aimed at promoting environmental sustainability and social welfare.	Positive public perception and community engagement, but the impact on core banking operations and carbon reduction goals remains limited.	Patel et al. [29].
development of carbon footprint measurement	Banks are developing tools and frameworks for measuring and	Emerging trend; these tools are improving transparency and	Kumar [30];

tools and reporting frameworks	reporting their carbon footprint and environmental impact.	accountability, but their full impact is still unfolding.	Jayadatta [31].
Efficiency improvements in Indian public sector banks post banking reforms	Efficiency improvements resulting from banking sector reforms, indirectly contributing to sustainability.	Indirectly supports sustainability by enhancing financial stability, although it is not explicitly focused on decarbonization.	Kumar [30].
improvements through green technology investments	Investment in green technologies aimed at reducing operational costs and improving energy efficiency.	Significant efficiency gains observed, leading to reduced operational costs and improved environmental impact.	Das et al. [32]; Bodla et al. [33].
Energy efficiency in bank operations	Adoption of energy-saving technologies and renewable energy sources for bank branches and ATMs.	Moderate effectiveness; energy efficiency measures are improving, but widespread implementation is slow. Although progress is being made, many banks still struggle to assess environmental risks effectively, leading to inconsistent application of ERM practices across the sector.	Ghosh et al. [2]; Sharma et al. [8]; Kaur [16].
Environmental Risk Management (ERM)	Integration of environmental risks into credit and operational decision-making to minimize carbon-related risks.	Effective in raising awareness, though impact on actual behavior change within the banking sector is slow.	Sarkar [9]; Datta [14].
Green banking awareness and training programs	Training employees on sustainable banking practices and raising awareness among customers regarding green banking services.	Moderate effectiveness; many banks have adopted these guidelines, but full implementation remains uneven.	Chandra et al. [13]; Ahuja [34].
Green banking policies and guidelines	Introduction of green banking guidelines by the Reserve Bank of India (RBI) to promote sustainability.	Effective in raising awareness and promoting sustainable finance, though challenges remain in scaling up across all banking operations.	Sharma et al. [8]; RBI [15]; Kaur [16].
Green banking practices	Promoting environmentally friendly banking practices such as reducing paper usage and encouraging eco-friendly products.	Moderate success, with a growing awareness among customers but limited uptake due to higher interest rates compared to traditional loans.	Sharma et al. [8]; Nair et al. [35]; Sharma et al. [8].
Green banking products (Loans, Mortgages)	Introduction of eco-friendly loans and mortgages to promote green buildings and energy-efficient homes.	Effective within SBI but limited sector-wide impact due to challenges in resource allocation and regulatory frameworks.	Verma et al. [3]; Sahoo et al. [12].
Green banking strategies of state bank of India	State Bank of India has developed green banking strategies to incorporate sustainability into its operations.	High potential but limited adoption; green bonds are growing, but their market remains underdeveloped.	Deka [36].
Green bonds and sustainable finance products	Banks are issuing green bonds and creating financial products aimed at funding low-carbon projects.	Significant growth in financing green energy projects, though challenges remain in large-scale adoption and policy clarity.	Bansal [1]; Bansal et al. [20]; Kumar et al. [37].
Green financing for renewable energy projects	Banks have started prioritizing financing for renewable energy projects such as solar and wind energy.	Effective in raising awareness and initiating green banking practices, though scalability and integration challenges persist across the sector.	Roy [38]; Borkhade et al. [39].
green initiatives and environmental strategies adopted by Indian banks	Banks are implementing a variety of green initiatives to promote environmental sustainability.	Positive impact on sustainability practices with increasing adoption rates.	Kaur [16].
Green initiatives promoting	Banks provide financing for renewable energy projects like		Kaur [16].

renewable energy financing	solar and wind, aiming to promote sustainability.		Bansal et al. [1]; Ghosh et al. [2]; Ghosh et al. [4].
Green lending practices	Banks are promoting loans for renewable energy projects and sustainable businesses, such as solar and wind energy projects.	Green loans have increased in volume, but challenges include limited awareness and access to finance for smaller players. The impact on overall carbon reduction is still limited.	
Impact of banking sector liberalization on efficiency and reforms	Evaluating the effect of liberalization on the operational efficiency of Indian banks.	Positive impact on overall efficiency and financial stability, indirectly supporting sustainability goals through enhanced resource management.	Das et al. [32].
Implementation of sustainable finance frameworks aligning with global standards	Aligning banking operations with global standards for sustainable finance, such as the Green Bond Principles and ESG frameworks.	Encouraging progress; banks are increasingly committed to international sustainability goals, though challenges remain in full-scale implementation.	Menon et al. [22].
Inclusion of environmental criteria in loan approval processes	Environmental impact is considered during loan approvals to encourage sustainable practices.	Limited impact; challenges remain in assessing and verifying the environmental claims of borrowers, hindering effectiveness.	Jayadatta [31].
Incorporating ESG (Environmental, Social, Governance) criteria	Integration of ESG criteria in investment and lending decisions to promote sustainable businesses. Indian banks have partnered with international organizations such as the United Nations and the IFC to improve access to green financing and low-carbon technology.	Growing effectiveness; ESG adoption is increasing but varies greatly among different banks.	KPMG [7]; Sahoo et al. [12]; Ghosh [40].
Institutional Partnerships (UN, IFC)		Positive impact in terms of knowledge exchange and financial support for green projects, but the overall scale is small.	Ghosh et al. [10]; IFC [23].
Integration of eco-friendly practices into banking operations	Incorporating energy-efficient practices and environmentally conscious operations into daily banking activities.	Moderate success; faced with challenges due to regulatory and operational constraints.	Chaurasia [27].
Internal environmental risk management	Incorporation of environmental risks into the banks' risk management frameworks to assess and mitigate the impact of climate change.	Slowly evolving with few banks implementing full-scale risk management frameworks; still, much of the industry lags behind.	Sarkar et al. [9]; Chandra et al. [13]; Datta et al. [14].
Internal sustainability practices (Energy Efficiency)	Banks are implementing energy-efficient practices in their operations, including the use of renewable energy sources, green buildings, and waste reduction.	Varied effectiveness; large banks show significant progress, while smaller ones face challenges in resource allocation.	Ghosh et al. [2]; Sharma et al. [8].
Productive efficiency dynamics in Indian banks	Examining the dynamics of productive efficiency in Indian banks post-reforms.	Enhancements in operational efficiencies that help optimize resources, though not directly linked to environmental sustainability.	Gupta et al. [28].
Promotion of green consumer banking	Offering sustainable banking products for individuals, like green home loans and eco-friendly investment plans.	Moderate effectiveness; consumer adoption is growing but remains a niche market.	Sharma [41]; Rajesh [42]; Yadav et al. [43].

Promotion of renewable energy financing	Financial institutions like SBI and HDFC have focused on financing renewable energy projects such as solar and wind energy.	Effective in promoting green energy but limited by high upfront costs and lack of financial incentives for smaller projects.	Ghosh et al. [2]; Ghosh et al. [4]; Roy [38]. Chandra et al. [13], Kumar [30]; Sahoo et al. [44].
Public-private partnerships for green development Review of green banking initiatives in Indian banking sector	Collaboration between banks and government bodies to fund and support low-carbon development projects. A review of various green banking initiatives across India.	High potential but limited scale; partnerships are promising but need stronger institutional backing. Highlights progress but identifies gaps in uniformity and comprehensive integration across the sector. The adoption of ESG reporting is growing, but reporting standards and the quality of disclosures vary significantly across banks, limiting the utility of such reports for decision-making.	Menon et al. [22]. Mishra et al. [45]; Sharma et al. [46]. KPMG [7]; Sharma et al. [8]; Pradhan et al. [47]. Bansal et al. [1]; Verma et al. [3].
Sustainability reporting and disclosures	Banks are increasingly adopting Environmental, Social, and Governance (ESG) disclosures in their annual reports. Banks are integrating Environmental, Social, and Governance (ESG) criteria into their lending and investment decisions.	Initial success in improving the sustainability of their portfolios, but ESG implementation is still evolving. Increasing adoption with positive impacts on financing green projects. However, challenges in market penetration and scalability persist. Limited uptake among banks, with most sustainable investments concentrated in a few large institutions. The sector is still in the early stages of adopting comprehensive ESG policies.	Ghosh et al. [2]; Rajesh [42].
Sustainable finance and ESG initiatives	Banks offer products such as green bonds and sustainable loans to finance environmentally sustainable projects.		
Sustainable investment portfolios Technical efficiency analysis of Indian banks using DEA approach Technical efficiency and financial reforms in Indian commercial banking	Investment in sustainable businesses and divestment from high carbon-emitting sectors. Analyzing the operational efficiency of banks using the Data Envelopment Analysis (DEA) model. Studying the effects of financial reforms on the technical efficiency of Indian banks.	Provides insights into operational efficiencies but lacks specific focus on environmental impact or decarbonization efforts. Supports operational improvements but does not specifically assess the environmental impacts or green practices.	Karimzadeh [48] Bhattacharya et al. [49]. Ghosh et al. [2];
Waste and energy reduction initiatives	Banks like ICICI and SBI have initiated energy-saving measures in their branches and offices, such as LED lighting and energy-efficient buildings.	Effective in reducing operational costs and carbon emissions in individual branches, but not universally implemented.	Ghosh et al. [4]; Kaur et al. [16].

5.1.1. Key challenges identified

Table 2: Key challenges that hinder the progress of banking sector.

Challenge	Description	Citations
Client resistance	Customers, especially from high-emission industries, resist compliance with green banking policies and requirements.	Ghosh et al. [2]; Nair et al. [35].
Data and measurement challenges	Lack of standardized metrics and tools to measure and report carbon footprints effectively. Banks, especially public sector banks, show resistance to adopting green banking practices due to traditional financial models and risk-averse behavior.	Ghosh et al. [4]; Mahapatra [17].
Financial sector resistance to change	Perceived high costs and uncertain returns of green finance projects deter banks from fully engaging in sustainable investments.	Ghosh et al. [4]; Ghosh et al. [10].
Financial viability concerns	The high carbon intensity of investment portfolios and financing activities of banks remains a significant challenge to achieving decarbonization.	Ghosh et al. [4]; KPMG [7].
High carbon intensity of investment portfolios	Significant financial investment required for transitioning to green technologies and adopting sustainable practices deters adoption.	Ghosh et al. [10]; Mahapatra [17].
High costs of implementation	Lack of standardized metrics and reliable data to measure environmental impacts and the effectiveness of green banking practices.	Ghosh et al. [4]; KPMG [7].
Inadequate data and metrics for assessment	The market for green finance instruments such as green bonds is still underdeveloped in India, limiting the availability of capital for sustainable investments.	Datta [14]; Kumar et al. [50].
Inadequate green finance instruments	Lack of knowledge and expertise among bank employees and management regarding sustainability practices and decarbonization strategies.	KPMG [7]; Bansal et al. [20].
Insufficient awareness and expertise	Insufficient training and awareness among banking professionals regarding sustainability and decarbonization.	Sharma et al. [8]; Kaur [16].
Lack of awareness and capacity building	The absence of specific policies and regulatory guidelines for implementing green banking practices.	Bansal et al. [1]; Kaur [16].
Lack of clear regulatory frameworks	The demand for green banking products is still relatively low, making it difficult for banks to scale up green initiatives.	Chandra et al. [13]; Datta [14].
Lack of customer demand for green products	Absence of clear policies and guidelines for decarbonization and green banking practices hampers sector-wide consistency and progress.	Kaur [16]; Nath et al. [51].
Lack of regulatory frameworks	Insufficient disclosure and transparency regarding the environmental impact and carbon footprint of banks hinder accountability and progress toward sustainable practices.	Sarkar [9]; Chandra et al. [13].
Lack of transparency in sustainability reporting	Inadequate availability and adoption of tools like green bonds and ESG-compliant funding mechanisms.	Sahoo et al. [12]; Mishra et al. [45].
Limited access to green finance instruments	Many financial institutions lack the technical expertise and awareness required to implement effective decarbonization strategies.	Vennila et al. [11]; Sustainable Banking Network [52].
Limited awareness and capacity		Ghosh et al. [2]; Sharma et al. [8]

Limited collaboration	Insufficient partnerships between banks, regulators, and environmental organizations to drive decarbonization efforts.	Chandra et al. [13]; Ramakrishnan [18].
Limited Environmental Risk	Banks often fail to fully integrate environmental risks into their credit and investment decisions.	Datta [14]; Ghosh et al. [10].
Integration of Environmental Risk Management	Inadequate integration of environmental risk assessment in lending and investment decisions.	Ghosh et al. [2]; Datta [14].
Limited green finance instruments	Limited access to green finance tools like green bonds, which are crucial for driving investments in low-carbon initiatives.	Verma et al. [3]; Bansal et al. [20].
Limited integration of environmental risk management	Environmental risk management is not fully integrated into the operational strategies of banks.	Ghosh et al. [2]; Sarkar [9].
Low adoption of green finance instruments	Limited use of tools like green bonds, sustainability-linked loans, and ESG frameworks to fund low-carbon projects.	Vennila et al. [11]; Ramakrishnan [18].
Policy and institutional gaps	There are gaps in policy alignment between the financial sector and environmental sustainability goals, causing fragmented efforts and slow progress in decarbonization.	Chandra et al. [13]; Kaur [16].
Regulatory and policy alignment issues	Misalignment between national policies and banking sector goals on sustainability and decarbonization.	Ghosh et al. [2]; Government of India [5].
Resistance to change	Banks show reluctance in adopting green finance mechanisms due to a focus on short-term profitability.	Ghosh et al. [10]; Chandra et al. [13].
Resistance to change within financial sector	Banks face internal resistance to adopting green banking practices due to traditional business models.	Ghosh et al. [10]; Kumar [30].
Short-term profitability focus	Banks prioritize short-term profitability over long-term sustainability, hindering the adoption of green banking practices.	Sharma et al. [8]; Yadav et al. [43].
Technological barriers	Adoption of technologies required for decarbonization (e.g., green technologies, AI for risk assessment) faces challenges due to high costs and limited infrastructure.	Ghosh et al. [4]; Ghosh et al. [10].
Weak stakeholder engagement	Lack of collaboration between banks, regulators, and other stakeholders for promoting sustainable banking initiatives.	Park et al. [6]; Sustainable Banking Network [52].
Financial constraints	High costs and limited financial viability hinder the adoption of green banking and sustainable practices.	Bansal et al. [1]; Ghosh et al. [2]; Verma et al. [3]; KPMG [7]; Sharma et al. [8]; Chandra et al. [13]; RBI [15]; Ramakrishnan [18]; Roy [38].
Regulatory and policy hurdles	Gaps in regulatory frameworks and inconsistent policies create barriers to implementing green initiatives.	Australian Banking Association [53]; Government of India [5]; Chandra et al. [13]; RBI [15]; CSEP [24]; SBN [52]; Patel et al. [29].
Technological barriers	Lack of technological infrastructure and challenges in adopting sustainable technologies.	Ghosh et al. [4]; Sarkar [9]; Ghosh et al. [10]; Geels [54]; Mohan [55]; Deegan [56].
Social and cultural challenges	Resistance to change, lack of awareness, and socio-cultural dynamics impede green banking adoption.	Sahoo et al. [13]; Menon et al. [22]; Chaurasia [27]; Jayadatta [31]; Deka [36]; Bhattacharyya et al. [49].

5.1.2. Impact of challenges

- How these challenges are slowing down the decarbonization process.

The decarbonization process in the banking sector faces several critical challenges that hinder its progress. Institutional barriers play a significant role, as banks often resist adopting green finance mechanisms due to entrenched traditional business models and a focus on short-term profitability, which detracts from sustainability efforts. Furthermore, misalignment between national policies and banking sector sustainability goals creates fragmented efforts, reducing consistency and progress. Insufficient partnerships between banks, regulators, and environmental organizations further undermine coordinated decarbonization strategies.

Financial constraints also slow down the transition. The high costs of implementing green technologies and sustainable practices often deter banks, while uncertainty about the returns on green finance projects reduces their willingness to fully engage in sustainable investments. Technological and operational barriers exacerbate the situation. The adoption of green technologies, such as AI for environmental risk assessment or energy-efficient systems, is hampered by high costs and inadequate infrastructure. Additionally, the absence of standardized metrics for measuring carbon footprints and assessing the effectiveness of green initiatives undermines transparency and accountability in the sector.

Market and awareness challenges further impede progress. The low demand for sustainable banking products, such as green loans and bonds, reduces the motivation for banks to develop and promote such offerings. Compounding this issue, bank employees and management often lack the necessary knowledge and expertise to implement effective decarbonization strategies. Social and cultural resistance also plays a role, with clients, particularly in high-emission industries, resisting compliance with green banking policies. Broader socio-cultural dynamics and resistance to change within organizations and society further hinder the adoption of green banking practices.

Moreover, the lack of adequate financial instruments contributes to the slow pace of decarbonization. The market for tools such as green bonds and ESG-compliant funding mechanisms remains underdeveloped, limiting their availability and scalability. Together, these challenges necessitate the development of robust regulatory frameworks, targeted capacity-building initiatives, and stronger stakeholder partnerships to drive progress. Additionally, greater emphasis on the development of financial instruments and the adoption of advanced technologies is essential to accelerate the decarbonization of the banking sector.

6. Discussion

6.1. Interpretation of findings

The decarbonization of the Indian banking sector is a gradual process characterized by uneven progress. While private sector banks such as ICICI Bank and Axis Bank have proactively implemented green banking practices – such as financing renewable energy projects, issuing green bonds, and adopting energy-efficient operational measures, public sector banks and smaller institutions lag behind. The slow adoption in these segments stems from limited resources, insufficient regulatory enforcement, and cultural resistance to change.

The study identifies critical challenges such as the lack of a robust regulatory framework, high costs of implementing sustainable practices, and inadequate customer demand for green

products. Technological limitations, particularly in rural areas, exacerbate these issues, with many banks unable to invest in advanced tools for environmental risk assessment or efficient carbon footprint management. These findings highlight systemic barriers that need to be addressed to accelerate the decarbonization process.

However, the study also points to significant opportunities. The increasing global and domestic focus on green finance, along with innovations such as digital platforms and green bonds, can potentially reshape the sector. Banks that successfully navigate these challenges by leveraging innovative financial products and technologies will likely play a crucial role in achieving India's climate goals.

6.2. Comparison with existing literature

The findings of this research are consistent with prior studies that emphasize the critical role of financial institutions in addressing climate challenges. For example, Bansal et al. [1] and Ghosh et al. [2], argue that green banking can simultaneously promote environmental sustainability and enhance financial resilience. Similar to this study, earlier research highlights challenges such as financial constraints, resistance to change, and the lack of clear regulatory mandates [17].

However, this research makes a novel contribution by underscoring the disparity between private and public sector banks in implementing green banking practices. Public sector banks, often constrained by traditional risk-averse models, lack the agility of their private counterparts to adopt innovative solutions. This gap has not been extensively discussed in prior literature, which tends to focus on sector-wide trends rather than institutional differences.

Additionally, the study identifies the significant role of technological integration in facilitating decarbonization—a topic often relegated to broader discussions on digital transformation rather than being specifically linked to sustainability efforts in banking [57-59].

6.3. Implications for policy and practice

Based on the findings, the following policy and practice recommendations are proposed to address the barriers and leverage opportunities for decarbonization in the Indian banking sector:

6.3.1. Regulatory enhancements

- **Mandatory guidelines:** The Reserve Bank of India (RBI) should move beyond voluntary recommendations and mandate the integration of environmental risk management into credit and investment decisions. This can include requirements for carbon footprint disclosures, setting carbon reduction targets, and adhering to sustainability reporting standards.
- **Global alignment:** Aligning Indian banking regulations with international frameworks, such as the Task Force on Climate-related Financial Disclosures (TCFD) and Green Bond Principles, can help attract global investments and standardize practices.

6.3.2. Financial incentives

- **Subsidies and tax rebates:** To offset the high initial costs of green technology adoption, the government can offer subsidies or tax incentives to banks that meet specific sustainability milestones.
- **Expanding green bond markets:** Developing a robust domestic green bond market can enable banks to secure affordable capital for financing renewable energy and low-carbon projects, thereby addressing funding constraints.

6.3.3. Capacity building

- **Employee training:** Tailored programs should be introduced to equip banking professionals with the skills needed for environmental risk assessment, sustainable finance management, and carbon accounting.
- **Incorporating sustainability in education:** Banking training institutes and academic institutions can include green finance and sustainable banking in their curricula to create a pipeline of skilled professionals.

6.3.4. Technological investments

- **Advanced tools:** Banks should adopt technologies such as artificial intelligence (AI) for environmental risk assessment, blockchain for transparency in green bond issuance, and data analytics for tracking carbon footprints.
- **Partnerships:** Collaborations with technology providers can help smaller banks access affordable and scalable solutions for implementing sustainable practices.

6.3.5. Public awareness campaigns

- **Consumer engagement:** Educating consumers about the environmental benefits of green banking products through awareness campaigns can increase demand and incentivize banks to expand their green offerings.
- **Incentivizing green choices:** Banks can offer rewards or preferential terms for customers opting for sustainable banking products, such as green loans or eco-friendly mortgages.

6.3.6. Collaborative frameworks

- **Multi-stakeholder engagement:** Partnerships between banks, regulators, NGOs, and industry experts can facilitate resource sharing, knowledge exchange, and co-development of innovative solutions.
- **Pooling resources for green projects:** Collaborative initiatives can help address the financing gap for large-scale sustainable projects by pooling resources and reducing individual institutional risk.

Decarbonization is a critical imperative for the Indian banking sector, which holds a pivotal role in financing the country's transition to a sustainable, low-carbon economy. While challenges such as regulatory gaps, technological limitations, and financial constraints persist, strategic interventions—including enhanced regulations, financial incentives, capacity building, and technological innovation—can significantly accelerate progress. By embracing these measures, the sector can align with India's broader climate commitments and contribute meaningfully to global sustainability efforts.

7. Conclusion

7.1. Summary of key findings

7.1.1. Progress in decarbonization

Over the past decade, the Indian banking sector has made some strides toward decarbonization, with private banks taking the lead in adopting green banking practices. Initiatives such as issuing green bonds, financing renewable energy projects, and integrating energy-efficient operations reflect significant progress. For example, private banks like ICICI Bank and Axis Bank have issued green bonds and introduced green lending products, contributing to the growth of renewable energy projects in India.

However, public sector banks and smaller financial institutions are significantly lagging. These entities often lack the resources, technical expertise, and institutional support needed to implement sustainable practices comprehensively. As a result, the decarbonization efforts across the banking sector are uneven and fragmented.

7.1.2. Challenges identified

The study identifies several systemic challenges that hinder the sector's progress toward decarbonization:

- **Regulatory gaps:** The lack of mandatory regulatory guidelines for integrating environmental risks into lending and investment decisions leads to inconsistent adoption of green banking practices. Existing guidelines from the Reserve Bank of India (RBI) are voluntary and lack enforceability.
- **Financial constraints:** Banks face high costs in adopting green technologies and sustainable practices. This challenge is compounded by limited access to affordable green finance instruments like green bonds.
- **Technological barriers:** Many banks, particularly in rural areas, lack access to advanced technologies such as AI-driven tools for environmental risk management and blockchain for transparent green finance tracking.
- **Institutional resistance:** Cultural inertia within financial institutions often prioritizes short-term profitability over long-term sustainability goals, especially in public sector banks that are slow to innovate.
- **Low consumer demand:** Awareness of green banking products among Indian consumers is limited, leading to lower demand and reduced incentives for banks to scale up these offerings.

7.1.3. Opportunities for advancement

Despite these challenges, there are significant opportunities to accelerate decarbonization in the banking sector. Green finance instruments, digital technologies, and strategic partnerships among stakeholders can be leveraged to create a more sustainable financial ecosystem.

Collaborative efforts between banks, regulators, and technology providers hold the potential to address gaps in financing, technology, and expertise.

7.2. Implications for policy and practice

Based on the findings, the following recommendations for policy and practice are proposed to address the identified barriers and capitalize on existing opportunities:

7.2.1. Regulatory enhancements

- **Mandatory guidelines:** The RBI should move beyond voluntary recommendations and mandate the inclusion of environmental risk assessments in credit and investment decisions. This could include clear guidelines for carbon footprint disclosures and alignment with global sustainability reporting standards, such as the Task Force on Climate-related Financial Disclosures (TCFD).
- **Incentives for compliance:** Regulators should introduce mechanisms such as penalties for non-compliance and rewards for exemplary sustainability efforts to encourage consistent adoption across the sector.

7.2.2. Incentivizing green practices

- **Financial support:** The government can provide subsidies or tax rebates to banks that invest in green technologies or finance low-carbon projects. This will offset high initial costs and reduce financial risks associated with green investments.
- **Green bonds market:** Developing a robust domestic market for green bonds will provide banks with access to affordable capital for financing sustainable projects.

7.2.3. Technological innovation

- **Advanced tools:** Banks should adopt technologies such as AI for environmental risk management, blockchain for transparency in green finance, and data analytics for carbon footprint tracking.
- **Collaborations with technology providers:** Partnering with technology firms can help smaller banks access affordable and scalable solutions for implementing sustainability initiatives.

7.2.4. Capacity building

- **Employee training:** Banking institutions must invest in specialized training programs to equip employees with the skills needed for implementing green banking initiatives and managing environmental risks effectively.
- **Incorporating sustainability in education:** Banking training institutes and universities can introduce sustainable finance courses to create a pipeline of skilled professionals for the sector.

7.2.5. Public awareness campaigns

- **Consumer education:** Banks should launch campaigns to educate customers about the benefits of green banking products, such as green loans and eco-friendly investments.
- **Incentivizing green choices:** Offering rewards or preferential interest rates on green products can increase consumer adoption and drive market demand.

7.2.6. Collaborative frameworks

- **Stakeholder engagement:** Banks, regulators, non-governmental organizations (NGOs), and international organizations must collaborate to pool resources, share best practices, and co-develop innovative solutions.
- **Institutional partnerships:** Partnerships with international agencies, such as the International Finance Corporation (IFC), can provide Indian banks with access to expertise and funding for green initiatives.

7.3. Recommendations for stakeholders

7.3.1. Policymakers

Policymakers must develop and enforce comprehensive regulatory frameworks that mandate sustainability integration in the banking sector. Providing financial support, such as low-interest loans for green technology adoption, will further drive progress.

7.3.2. Banking institutions

Banks need to prioritize the integration of environmental, social, and governance (ESG) principles into their core operations. They must invest in green technologies and actively participate in developing green financial instruments to support low-carbon projects.

7.3.3. Consumers and NGOs

Consumers should be encouraged to demand sustainable banking products, creating market-driven pressures for banks to adopt green practices. NGOs can play a role in bridging knowledge gaps and advocating for environmentally responsible banking.

7.4. Future research directions

To build on this study, future research can explore the following areas:

7.4.1. Impact assessments

Evaluate the financial and environmental outcomes of specific green banking initiatives to identify best practices and inform policy.

7.4.2. Regional and institutional variations

Investigate how geographic and institutional differences influence the adoption and effectiveness of sustainable banking practices, particularly in underserved regions. The decarbonization of the Indian banking sector is both a challenge and an opportunity. While significant strides have been made in integrating green banking practices, substantial gaps remain, particularly among public sector banks and smaller institutions. By addressing regulatory, financial, technological, and cultural barriers, and by fostering collaboration among stakeholders, the sector can play a pivotal role in India's transition to a sustainable, low-carbon economy. The findings of this study provide a roadmap for future actions that can help align the banking sector with India's climate goals, ensuring environmental resilience and long-term economic growth.

References

1. Bansal P, Sharma N. Green banking: a review. *Ind J Comm Mgmt Stud.* 2017;8:48-56.
2. Ghosh S, Kathuria V. Green banking in india: progress and challenges. *J Environ Mgmt.* 2020;262:110365.
3. Verma S, Sharma R. Green finance and sustainable development in Indian banking sector: a review. *Int J Sust Dev World Ecol.* 2022;29:41-56.
4. Ghosh D, Dey S. Carbon footprint and carbon management practices in Indian banks. *Mgmt Environ Quality: an Int J.* 2018;29:641-61.
5. https://moef.gov.in/uploads/2024/01/INDIA_BUR-3.pdf
6. Park H, Kim JD. Transition towards green banking: role of financial regulators and financial institutions. *Asian J Sustain Soc Respons.* 2020;5:1-25.
7. KPMG. ESG and Indian banking: current state and future outlook. 2021.
8. Sharma A, Sahu S. Sustainable banking practices and green finance in India: a study. *Fin India.* 2020;34:81-100.
9. Sarkar S. Integrating environmental risk management in Indian banks: issues and challenges. *J Risk Manag Fin Inst.* 2020;13:414-34.
10. Ghosh A, Nanda P. Technological challenges in the decarbonization of Indian banks. *Sustainable Development.* 2021;29:481-90.
11. Vennila D, Sina ES. Sustainable finance: the role of Indian banks in achieving the sustainable development goals-2022. *Towards Excellence.* 2022;14:797-814.
12. Sahoo D, Bhunia A. Socio-cultural dynamics of green banking adoption in India. *Asian J Soc Sci.* 2021;49:230-48.
13. Chandra P, Sudhakar B. Policy frameworks for green banking in India: challenges and opportunities. *J Banking Fin Mgmt.* 2019;2:14-28.
14. Datta P. Integrating environmental risk management into Indian banking sector: a systematic review. *J Environ Mgmt.* 2023;301:113936.
15. Reserve Bank of India (RBI). Guidelines on green banking. 2015.
16. Kaur G. Green initiatives of banks in India: a paradigm shift. *J Com Manag Thought.* 2016;7:488-500.
17. Mahapatra S. Assessment of carbon footprint in Indian banking sector: a case study approach. *J Clean Prod.* 2021;280:124560.
18. Ramakrishnan M. Sustainable finance in India: challenges and opportunities. *J Sustain Fin Invest.* 2019;9:202-20.

19. Sengupta A. Sustainable finance: a new attitude of Indian banking sector. UGC CARE J. 2020;68;51.
20. Bansal S, Mani SP, Gupta H, et al. Sustainable development of the green bond markets in India: challenges and strategies. *Sust Dev.* 2023;31:237-52.
21. Fathima J. Digital revolution in the Indian banking sector. *Int J Comm.* 2020;8:56-64.
22. Menon DG, Sreelakshmi SG, Shivdas A. Green banking initiatives: A review of Indian banking sector. Proceedings of the International Conference on Technological Advancements in Power and Energy, India. 2017.
23. International Finance Corporation (IFC). Unlocking green finance in developing countries. 2020.
24. Das S. Building a sustainable future: the role of banks in India. Centre for Social and Economic Progress (CSEP). 2020.
25. Saravia F. Towards a sustainable economy: banking on a low-carbon future. European Banking Federation. 2020.
26. Raut R, Cheikhrouhou N, Kharat M. Sustainability in the banking industry: a strategic multi-criterion analysis. *Business Strategy and the Environment.* 2017;26:550-68.
27. Chaurasia A. Green banking practices in Indian banks. *Environ Sci Bus.* 2014.
28. Gupta O, Jain PK. Dynamics of productive efficiency of Indian banks. *Int J Oper Res.* 2008;5:78-90.
29. Patel A, Patel S. Corporate social responsibility initiatives in Indian banking sector: a review. *J Bank Regul.* 2021;22:31-49.
30. Kumar S. Banking reforms and the evolution of cost efficiency in Indian public sector banks. *Econ Change Restructuring.* 2013;46:143-82.
31. Jayadatta S, Nitin SN. Opportunities, challenges, initiatives and avenues for green banking in India. *Int J Bus Manag Inven.* 2017;6:10-5.
32. Das A, Ghosh S. Financial deregulation and efficiency: an empirical analysis of Indian banks during the post reform period. *Rev Fin Econ.* 2006.
33. Bodla BS, Bajaj RV. An analysis of the efficiency of private sector banks in India. *IUP J Bank Mgmt.* 2010;9:1-23.
34. Ahuja N. Green banking in India: a review of literature. *Int J Res Manag Pharm.* 2015;4:11-6.
35. Nair RR, Pradhan S. Green banking in India: a review. *Int J Bank Mark.* 2019;37:1288-314.

36. Deka G. Green banking practices: a study on environmental strategies of banks with special reference to state bank of India. *Ind J Commerce & Manag Stud.* 2015;6:11-9.
37. Kumar K, Prakash A. Developing a framework for assessing sustainable banking performance of the Indian banking sector. *Soc Respons J.* 2019;15:689-709.
38. Roy A. Financing renewable energy in India: the way forward. *Renew Energy.* 2018;123:141-50.
39. Borkhade R, Bhat KS, Mahesha GT. Implementation of sustainable reforms in the Indian automotive industry: from vehicle emissions perspective. *Cogent Eng.*2022;9:2014024.
40. Ghosh K. Green initiatives by banking sector in India. *Eurasian J Man Soc Sci.* 2021;1:38-47.
41. Sharma K. Green banking in India: a roadmap to success. *IBMRD J Mgmt Res.* 2013;2:229-39.
42. Rajesh S. Green banking practices in India: opportunities and challenges. *Asian J Manag Comm.* 2022;3:161-65.
43. Yadav R, Pathak G. Environmental sustainability through green banking: a study on private and public sector banks in India. *OIDA Int J Sustain Dev.* 2013;6:37-48.
44. Sahoo P, Nayak BP. Green banking in India. *Ind Econ J.* 2007;55:82-98.
45. Mishra P, Sant TG. Examine the level of environmental, social and governance disclosure in sustainability report—a study of the Indian banking sector. *Int J Innov Sci.* 2024;16:420-42.
46. Sharma M, Choubey A. Green banking initiatives: a qualitative study on Indian banking sector. *Environ Dev Sustain.* 2022;24:293-319.
47. Pradhan KK, Krishna RS. Green finance and sustainable investment: navigating the landscape in India. *J Inform Educ Res.* 2024;4:911-16.
48. Karimzadeh M. Efficiency analysis by using data envelop analysis model: Evidence from Indian banks. *Int J Latest Trends Fin Eco Sc.* 2012;2:228-37.
49. Bhattacharyya A, Pal S. Financial reforms and technical efficiency in Indian commercial banking: a generalized stochastic frontier analysis. *Rev Fin Econ.* 2011;22:109-17.
50. Kumar K, Prakash A. Examination of sustainability reporting practices in Indian banking sector. *Asian J Sustain Soc Respons.* 2019;4:1-16.
51. Nath V, Nayak N, Goel A. Green banking practices—A review. *IMPACT: Int J Res Bus Manag.* 2014;2:45-62.
52. Sustainable Banking Network (SBN). Progress report: sustainable banking practices in India. 2018.

53. Australian banking association. Banks and Sustainable Finance. 2019.
54. Geels FW. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res Policy*. 2002;31:1257-74.
55. Mohan R. Digital transformation in Indian banking: the road ahead. *Bank Fin Rev*. 2020;12:45-60.
56. Deegan C. Introduction: the legitimising effect of social and environmental disclosures—a theoretical foundation. *Acct, Audit Accountability J*. 2002;15:282-311.
57. Sarkar D, Latta A. Role of banking system in green finance in the context of India: an analysis. *Asian J Manag*. 2022;13:227-34.
58. Choubey A, Sharma M. Green banking: the case of the commercial banking sector in Delhi NCR. *J Environ Plann Manag*. 2022;65:1975-98.
59. Srivastava S, Srivastava T. A systematic review of the digital banking challenges in the Indian banking sector. *Int J Innov Res Eng Manag*. 2022;11:94-9.