

Green Banking 5.0: An AI-Driven ESG and Climate Risk Framework for Sustainable Banking in India

Priya Ranjan

Manager (Projects)

Steel Authority of India Limited (SAIL) – IISCO Steel Plant Burnpur, Paschim Bardhaman, West Bengal, India

MBA (Finance) Scholar

Mizoram University, Aizawl – 796004, Mizoram, India

Official Email: priya.r@sail.in, Alternate Email: priya.bitmet@gmail.com

Abstract - The transition toward sustainable finance has become a strategic priority for the global banking industry due to increasing climate change risks, stricter environmental regulations, and the growing demand for responsible investment practices. In India, banks are progressively adopting digital technologies and environmentally sustainable financial services; however, the integration of Artificial Intelligence (AI), Environmental, Social and Governance (ESG) analytics, climate risk assessment, and carbon-aware lending into a unified decision-making framework remains limited (1). Existing studies primarily focus on digital banking and paperless operations, with comparatively less attention given to AI-enabled sustainability intelligence and predictive environmental risk management (2).

The present study proposes a Green Banking 5.0 framework that integrates AI-driven analytics, ESG evaluation, climate-risk assessment, and carbon-conscious lending to support sustainable financial decision-making in the Indian banking sector. The study employs a descriptive and analytical research design using both primary data collected from 120 banking customers through a structured questionnaire and secondary data obtained from published literature, banking reports, government publications, and sustainability documents (3). Statistical analysis includes percentage analysis, comparative interpretation, and graphical representation to evaluate customer awareness, adoption of green banking services, and perceptions regarding sustainable banking initiatives (4).

The findings indicate that customers increasingly prefer digital and environmentally friendly banking services because of their convenience, operational efficiency, and reduced environmental impact. Furthermore, AI-assisted ESG assessment and climate-risk analytics have significant potential to improve credit appraisal, strengthen risk management, and encourage sustainable investment decisions while supporting India's long-term climate and net-zero objectives (5). Despite these opportunities, several challenges remain, including inadequate ESG data availability, cybersecurity concerns, technological infrastructure limitations, and the absence of standardized sustainability reporting frameworks (6).

The proposed Green Banking 5.0 framework provides a comprehensive conceptual model that combines digital transformation with sustainable finance and offers practical guidance for banks, regulators, and policymakers seeking to

strengthen environmentally responsible financial systems. The study contributes to the emerging literature on AI-enabled sustainable banking by presenting an integrated approach for future-ready banking aligned with Industry 5.0 principles and global sustainability goals (7).

Keywords: Green Banking 5.0; Artificial Intelligence; ESG Analytics; Climate Risk Assessment; Sustainable Finance; Carbon-Aware Lending; Digital Banking; Industry 5.0.

1. Introduction

The banking sector plays a vital role in promoting sustainable economic development by integrating environmental responsibility with financial services. Rapid digital transformation, increasing environmental concerns, and global commitments toward sustainable development have encouraged financial institutions to adopt environmentally responsible banking practices. Green Banking has emerged as an effective approach to reducing the environmental impact of banking operations through paperless transactions, digital banking services, energy-efficient infrastructure, and sustainable financing. In recent years, the concept has evolved beyond traditional green initiatives toward **Green Banking 5.0**, which integrates Artificial Intelligence (AI), Environmental, Social and Governance (ESG) analytics, climate-risk assessment, and advanced digital technologies into banking operations and lending decisions. This integrated approach enables financial institutions to improve operational efficiency, strengthen environmental risk management, promote responsible lending, and support low-carbon economic growth (3, 4, 5, 6).

India has made significant progress in promoting digital financial inclusion through internet banking, mobile banking, Unified Payments Interface (UPI), and other digital payment systems. Simultaneously, regulatory initiatives and sustainability commitments have encouraged banks to incorporate ESG principles and climate-related considerations into their strategic planning and financial decision-making. Despite these developments, challenges such as cybersecurity risks, limited digital literacy, inadequate ESG data, and technological disparities between urban and rural areas continue to affect the widespread adoption of Green Banking 5.0 (1, 2, 9, 13).

The present study examines customer awareness, adoption, and perceptions of Green Banking 5.0 services in India based on primary data collected from 120 respondents. It also proposes a comprehensive Green Banking 5.0 framework integrating AI-enabled banking, ESG-based decision-making, climate-risk assessment, and carbon-aware lending. The study aims to provide practical recommendations for banks, policymakers, and researchers to strengthen sustainable banking practices and support India's transition toward an environmentally responsible and digitally empowered financial system (21, 28, 31, 32).

2. Objectives of the Study

- To identify and analyse meaning and significance of green banking.
- To study the various strategies adopted by Indian banks in order to implement green banking practices.
- To analyse the level of customer awareness on the various services offered through the facilities of green banking.
- To understand and assess the various benefits that arise from green banking on the basis of environment and also on the basis of economy.
- To determine and understand the various difficulties encountered in implementing the green banking practices.
- To understand and evaluate the role and significance of the various green banking practices on the basis of sustainable development.
- To give recommendations and solutions for better implementation of the green banking practices.
- Design and integrate a Green Banking 5.0 AI framework with capabilities for ESG analysis, climate risk assessment and carbon-conscious lending to inform strategic financial decisions and drive sustainable finance.

3. RESEARCH METHODOLOGY

3.1 Research Design

The present study adopts a descriptive and analytical research design to examine customer awareness, adoption, and perceptions of Green Banking 5.0 practices in India. The study combines both primary and secondary data to investigate the role of digital banking, Artificial Intelligence (AI), Environmental, Social and Governance (ESG) analytics, and sustainable banking practices in promoting environmentally responsible financial systems. This research design enables a systematic analysis of customers' responses while providing insights into the emerging trends in sustainable banking. (11)

3.2 Data Sources

The study is based on both primary and secondary sources of data.

Primary Data

Primary data were collected through a structured questionnaire administered to bank customers. A total of 120 respondents from urban and semi-urban areas participated in the survey. The questionnaire was designed to collect information on customers' awareness, usage, perceptions, and preferences regarding green banking services, digital banking, and environmentally sustainable banking practices. (12)

Secondary Data

Secondary data were collected from authentic and reliable sources to support the conceptual and analytical framework of the study. The major sources included:

- Reserve Bank of India (RBI) Reports
- Research Journals
- Bank Publications and Annual Reports
- Sustainability Reports
- Government Publications
- Banking and Financial Websites
- Finance and Sustainable Development Research Articles

These secondary sources were utilized to understand recent developments in green banking, sustainable finance, Artificial Intelligence, ESG analytics, and climate-risk management. (13)

3.3 Sample Size and Sampling Technique

The study was conducted using a sample of 120 bank customers selected from urban and semi-urban regions. A Convenience Sampling technique was adopted because it facilitated easy access to respondents who actively use banking services and digital financial platforms. Although probability sampling methods generally provide broader representation, convenience sampling was considered appropriate for this exploratory study due to time and accessibility constraints. (14)

3.4 Research Instrument

A structured questionnaire was used as the primary research instrument for data collection. The questionnaire consisted of questions related to demographic characteristics, awareness of green banking, usage of digital banking services, customer perceptions regarding sustainable banking practices, and the adoption of environmentally friendly banking initiatives. The questionnaire was designed to obtain reliable responses for descriptive statistical analysis. (15)

The complete questionnaire used for primary data collection is provided in Appendix A.

3.5 Statistical Tools Used

The collected data were analysed using both descriptive and inferential statistical techniques to examine customer awareness, adoption, and perceptions regarding Green Banking 5.0 services. The following statistical tools were employed:

- Percentage Analysis
- Comparative Interpretation

- Tabular Representation
- Graphical Analysis
- Chi-square Test of Independence

Percentage analysis was used to summarize respondents' demographic characteristics and banking preferences. Comparative interpretation was applied to examine differences in customer awareness and usage patterns. Tabular and graphical representations were used to present the survey findings in a clear and systematic manner. The Chi-square Test of Independence was identified as an appropriate statistical technique for examining the association between customer awareness and the usage of Green Banking services because both variables are categorical in nature. The test provides a framework for assessing whether an association exists between these variables at the prescribed level of significance. These statistical techniques collectively provide a comprehensive understanding of customer behaviour and the adoption of sustainable banking practices. (16)

3.6 Ethical Considerations

Participation in the survey was entirely voluntary. Before collecting responses, all participants were informed about the purpose of the research. No personally identifiable information was collected, and the confidentiality and anonymity of the respondents were maintained throughout the study. The collected data were used solely for academic and research purposes, and ethical standards relating to privacy, informed consent, and responsible data handling were strictly followed. (17)

4. Literature review

Green banking has emerged as a significant component of sustainable finance by integrating environmental responsibility into banking operations, lending practices, investment decisions, and corporate governance. Initially, green banking primarily focused on reducing paper consumption, promoting electronic transactions, and financing environmentally friendly projects. However, the increasing challenges associated with climate change, carbon emissions, and sustainable economic development have expanded the scope of green banking beyond operational efficiency toward strategic financial decision-making. Financial institutions are now expected to incorporate environmental considerations into credit appraisal, investment portfolios, and long-term risk management practices to support sustainable development goals. (1)

The rapid advancement of digital technologies has accelerated the transformation of banking services across the world. Internet banking, mobile banking, cloud computing, blockchain, and digital payment platforms have significantly improved operational efficiency while reducing resource consumption and environmental impact. These technological innovations have enabled banks to minimize paper-based documentation, reduce operational costs, enhance customer convenience, and improve financial inclusion. Consequently, digital banking has become one of the major driving forces

supporting green banking initiatives in both developed and developing economies. (2)

Artificial Intelligence (AI) has become an important technological enabler for sustainable banking. AI techniques, including machine learning, predictive analytics, natural language processing, and intelligent automation, allow banks to analyze large volumes of structured and unstructured data for better financial decision-making. AI applications improve fraud detection, customer relationship management, loan risk assessment, portfolio optimization, and environmental risk monitoring. More recently, AI has been increasingly utilized to evaluate climate-related financial risks and support sustainability-oriented investment decisions. (3)

Environmental, Social, and Governance (ESG) analytics has gained substantial importance in modern banking due to growing investor expectations, regulatory requirements, and corporate sustainability commitments. Financial institutions are increasingly incorporating ESG indicators into their lending and investment strategies to identify environmentally responsible organizations and minimize long-term financial risks. ESG-based assessment enables banks to evaluate borrowers not only on their financial performance but also on their environmental impact, social responsibility, and governance quality, thereby promoting responsible financing and sustainable economic growth. (4)

Climate-related financial risks have become one of the major concerns for banking regulators and financial institutions worldwide. Physical risks arising from floods, droughts, heatwaves, and other extreme weather events, together with transition risks associated with carbon regulations and decarbonization policies, significantly influence the stability of financial systems. Consequently, climate risk assessment has become an essential component of modern banking, enabling financial institutions to evaluate exposure to climate-sensitive sectors and improve long-term portfolio resilience through informed lending decisions. (5)

Carbon-aware lending has recently emerged as an innovative approach to sustainable finance. Under this framework, banks incorporate carbon emission performance and environmental sustainability indicators into credit evaluation and loan pricing decisions. Organizations demonstrating lower carbon intensity and stronger environmental performance may receive preferential financing conditions, encouraging industries to adopt cleaner technologies and sustainable production systems. This approach supports national climate policies while strengthening the environmental performance of financial institutions. (6)

Although previous studies have extensively examined digital banking, environmental sustainability, renewable energy financing, customer awareness, and green banking practices, relatively limited research has investigated the integrated application of Artificial Intelligence, ESG analytics, climate-risk assessment, and carbon-aware lending within a unified banking framework. Most existing research evaluates these

dimensions independently, creating a gap in understanding how advanced digital intelligence can collectively support sustainable financial decision-making in Indian banks. (7)

To address this research gap, the present study proposes the **Green Banking 5.0** framework, which integrates Artificial Intelligence, ESG analytics, climate-risk assessment, carbon-aware lending, and digital banking technologies into a comprehensive sustainability-oriented financial decision-making model. The proposed framework aims to enhance environmental responsibility, improve credit risk evaluation, strengthen sustainable investment practices, and support India's transition toward a resilient, low-carbon, and technology-driven financial system aligned with Industry 5.0 principles. (8)

5. Research Gap

The existing literature on green banking has primarily concentrated on digital banking adoption, paperless banking operations, renewable energy financing, customer awareness, and environmentally sustainable banking practices. Several studies have examined the influence of digital technologies on banking efficiency and environmental sustainability, while others have emphasized the importance of green finance in promoting low-carbon economic development. However, these studies generally investigate these dimensions independently rather than as components of an integrated sustainable banking ecosystem. (1)

Recent studies have highlighted the growing importance of Artificial Intelligence (AI) in financial services, particularly in fraud detection, customer relationship management, predictive analytics, and credit risk assessment. Similarly, Environmental, Social, and Governance (ESG) frameworks have become increasingly important in evaluating corporate sustainability and responsible investment decisions. Despite these developments, very limited research has attempted to integrate AI-driven analytics with ESG evaluation and climate-risk assessment into a unified green banking decision-making framework suitable for emerging economies such as India. (2)

Climate-related financial risks have become increasingly significant due to global climate change, carbon reduction policies, and the transition toward low-carbon economies. Although international regulatory organizations encourage financial institutions to incorporate climate-risk assessment into lending and investment decisions, empirical studies addressing the practical implementation of climate-risk models within Indian banking institutions remain limited. Most available research discusses climate finance conceptually without proposing operational frameworks that banks can implement in their lending processes. (3)

Furthermore, carbon-aware lending has recently emerged as an important component of sustainable finance. Existing studies acknowledge its potential to encourage environmentally responsible investments; however, there is insufficient research explaining how carbon emission indicators, ESG performance, and AI-based predictive models can be simultaneously

incorporated into banking credit appraisal systems. The absence of such integrated approaches restricts the ability of banks to make data-driven and environmentally responsible financial decisions. (4)

Another important limitation identified in previous research is the lack of comprehensive frameworks aligned with the principles of Industry 5.0. Most published studies continue to emphasize digital banking transformation under Industry 4.0, while comparatively little attention has been given to human-centric, sustainable, and AI-enabled financial ecosystems that integrate advanced digital intelligence with environmental responsibility. Consequently, there remains a significant research gap in developing a practical Green Banking 5.0 framework capable of supporting sustainable banking transformation in India. (5)

To address these research gaps, the present study proposes an integrated **Green Banking 5.0 Framework** that combines Artificial Intelligence, ESG analytics, climate-risk assessment, carbon-aware lending, and digital banking technologies into a unified decision-support model. The framework aims to improve sustainable financial decision-making, strengthen environmental risk management, promote responsible lending, and support India's transition toward a resilient and environmentally sustainable banking system consistent with Industry 5.0 principles and global sustainability goals. (6)

6. The Hypothesis of the Study

Null Hypothesis (H0): There is no significant association between awareness about green banking services and usage of green banking services by the customers.

Alternative Hypothesis (H1): There is a significant association between awareness about green banking services and usage of green banking services by the customers.

6.1 Hypothesis Testing Approach

6.1 Hypothesis Testing Approach

The proposed hypothesis was formulated to examine whether customer awareness significantly influences the usage of Green Banking services. Since the study is based on primary data collected from 120 respondents through a structured questionnaire, an inferential statistical approach is considered appropriate for testing the relationship between awareness and adoption of Green Banking practices.

To examine this relationship, the Chi-square Test of Independence was selected because both variables (awareness and usage of Green Banking services) are categorical in nature. The test determines whether there is a statistically significant association between the two variables.

The hypotheses were tested at a 5% level of significance ($\alpha = 0.05$). If the calculated p-value is less than 0.05, the null hypothesis (H0) will be rejected and the alternative hypothesis (H1) will be accepted,

indicating that customer awareness has a significant influence on the usage of Green Banking services. Conversely, if the p-value is greater than 0.05, the null hypothesis will not be rejected, indicating that no statistically significant association exists between the two variables.

The results of the hypothesis testing are presented in the Data Analysis and Interpretation section of this study.

Green Banking 5.0 is defined as next stage of sustainable banking by the use of AI, ESG, climate-risk analysis and digital technologies to influence credit decisions. In contrast to conventional green banking practices focusing on non-paper transaction and online services, Green Banking 5.0 looks beyond simple eco-friendly measures and involves climate responsible lending, carbon efficient credit allocation, and predictive environmental risk management (6).

The model is comprised of:

- AI-based data analysis;
- ESG assessment system;
- Climate risk assessment;
- Carbon footprint monitoring;
- Sustainable lending;
- Ongoing tracking of environmental performance;

Green Banking is a sustainable oriented strategy under which banks embed environment consciousness into the banks' operations, loan portfolio and decision-making process. The aim is to promote minimal environment footprint and maintain sustainable practices through green banking. Banks are encouraged to adapt modern digital technology to lower resource consumption, deliver faster service, foster sustainable business activities and support green investments.

Key elements of Green Banking 5.0.

- AI enabled banking services
- Digital and mobile banking
- Cloud based finance transactions
- Paperless customers' on-boarding and documentation
- Electronic statements and digital documents
- Sustainable and green finance scheme
- Financing for renewable projects
- ESG based lending and investment process
- Carbon aware credit appraisal process
- Green branch operations.

The practice not only ensures environmental benefits but also results in enhancement of banks' operation efficiency, reduction of operational costs and administrative expenses, fast delivery of services, enhanced customer satisfaction and banks' overall sustainable performance.



Figure 1. Green Banking 5.0 Concept

The concept of green banking has emerged as a prominent tool to balance the dual goals of economic development and environmental preservation. By adopting measures like online transaction, reduced paper work and eco-friendly loans banks and customers work in coordination to cut down on carbon emission and operation costs. While awareness and technological factors are seen as the driving force of green banking the challenges posed by cyberspace and internet penetration in rural areas still need to be addressed. Enhancing the infrastructure and raising awareness along with governmental support can play a pivotal role in turning green banking into a vital player in sustainable financial development of India.

7. Conceptual Framework of Green Banking 5.0

Green Banking 5.0 represents the next generation of sustainable banking by integrating Artificial Intelligence (AI), Environmental, Social and Governance (ESG) analytics, climate-risk assessment, carbon-aware lending, and advanced digital banking technologies into a unified financial decision-making framework. Unlike conventional green banking, which mainly emphasizes paperless transactions and digital banking services, Green Banking 5.0 adopts a holistic approach that combines technological innovation with environmental sustainability and responsible financial management. The framework enables banks to evaluate borrowers not only on their financial performance but also on environmental risks, carbon emissions, ESG performance, and long-term sustainability, thereby supporting responsible lending and sustainable economic development. (8)

The proposed framework consists of five major pillars. Artificial Intelligence enables predictive analytics, automated credit assessment, fraud detection, and intelligent decision support using large volumes of financial and environmental data. ESG analytics assists banks in evaluating borrowers' environmental performance, social responsibility, and governance standards before making lending decisions. Climate-risk assessment measures the potential financial impact of climate-related physical and transition risks on banking portfolios, while carbon-aware lending integrates carbon emission indicators into loan appraisal and pricing mechanisms. These components are supported by digital banking technologies such as cloud computing, mobile banking, electronic documentation, and secure digital platforms, which improve operational efficiency while reducing environmental impact. (9)

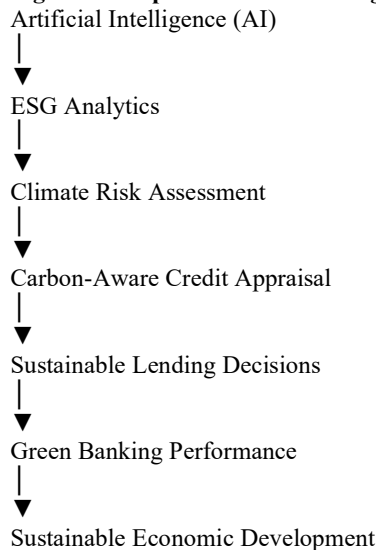
The integration of these components creates a comprehensive Green Banking 5.0 ecosystem that strengthens sustainable financial decision-making, improves risk management, promotes responsible investment, and supports India's transition toward a low-carbon and environmentally sustainable financial system. The framework aligns with Industry 5.0 principles by combining technological innovation with human-centric and sustainability-oriented banking practices. (10)

7.1 Components of Green Banking 5.0

The proposed framework consists of the following interconnected components:

- Artificial Intelligence (AI)-based Decision Support
- ESG Analytics and Sustainability Assessment
- Climate-Risk Assessment
- Carbon-Aware Credit Appraisal
- Sustainable Lending and Green Investment
- Digital Banking Infrastructure
- Continuous Sustainability Performance Monitoring

Figure 1. Proposed Green Banking 5.0 Framework



8. Sustainable Banking Practices in India

Indian banks are increasingly embracing sustainability principles within their operations and financial structures. Supported by the rise of digital technologies, sustainable finance mechanisms, and environmentally conscious infrastructure, this paradigm shift toward greener banking is gaining momentum.

8.1 Technology-Led Banking Solutions

Financial institutions are nudging their customers toward using online platforms for day-to-day banking activities in an effort to minimize reliance on physical banking branches. The proliferation of mobile banking applications, internet banking

portals, and contactless payment solutions has dramatically changed service delivery while cutting down resource utilization.

Essential Benefits:

- Reduction in the use of paper-based documentation.
- Greater transaction speed and efficiency.
- Lower operating costs and operational expenses.
- Accessibility to customers in remote areas.
- Smaller carbon footprint from banking operations.

8.2 Digital Documentation and Communication

Many banks are gradually substituting paper documents with an electronic record-keeping system. Through the digitization of bank account statements, sending customers alerts and notifications through the internet, and utilizing cloud storage for storing financial records, paper consumption in the banking sector can be significantly lowered while boosting data availability.

8.3 Sustainable Finance and Green Investments

A good number of banking establishments have widened their scope beyond conventional lending and are channelling funds into projects that align with environmental protection objectives. Funding has increasingly been diverted toward businesses in clean energy sectors and efficient use of resources.

Key sectors under the umbrella of green financing:

- Power generation based on renewable sources.
- E-mobility and infrastructure development for charging electric vehicles.
- Buildings-both residential and commercial-that use electricity efficiently.
- Public transportation networks focused on sustainability.
- Infrastructure for climate-resilient development.

8.4 Environmentally Friendly Banking Infrastructure

A few banks are in the process of upgrading their branches with sustainable and energy-efficient technologies to promote responsible banking, and this move is contributing to the lowering of their operating costs, and reducing their carbon emissions.

Typical green building components:

- Smart systems to manage energy usage.
- Solar panels on rooftops.
- Systems to harvest and recycle rainwater.
- Energy-efficient lighting solutions.
- Building design practices that are carbon-conscious.

These trends show the Indian banking sector's commitment to the twin goal of profitability and ecological sustainability, and this practice is likely to take centre stage in India's move to become a green financial system.



Pic. 2

- Encouraging digital banking. India's many banks are urging their customers to make use of services through digital channels, further reducing paper consumption and trips to the branch.
- Green Banking and the paperless trend. Through the use of e-statements and the adoption of the online mode of transaction, the paper requirement is declining with this movement towards green banking.
- Funding green energy sources. India's banks are encouraging green banking not just by going paperless, but also by providing funding to the solar power sector and to the renewable sources of energy such as EVs. Other such green projects are also being provided with funds and the support of loans from banks.
- Green Banking Branches. From LED lighting and solar panels on the rooftops of a few bank branches to the implementation of the system of water harvesting at a lot of branches across India, energy efficient appliances and tools are being introduced in some branches along with these aforementioned methods.
- Economic benefits. The change to green banking offers a reduction in operating costs for banks in addition to saving the environment. Along with the reduced costs of operating a branch, the increase in service speed is also offering ease of banking to customers.
- Conserving the environment. Initiatives such as those of green banking are enabling India to save water, natural resources, and in essence reduce carbon emissions from its environment.
- Green banking as the path to a sustainable future. By implementing a set of initiatives of green banking, the

traditional financial sector of the country is being brought closer to using and adapting to environment friendly methods and new age sustainable finance is being developed in India.

8.5 Artificial Intelligence in Green Banking

Artificial Intelligence is an exciting disruptive technology in the context of sustainable banking. Through AI-based tools, banks can better understand their customers' needs and behaviours, analyse environmental risks and prevent fraudulent activities as well as enhancing the bank's overall operations (7). By leveraging machine learning models, banks are able to process large datasets on climate risks and ESG factors and use them for making lending decisions. AI is beneficial in that it can also be used for predictive analytics where financial institutions can predict environmentally sustainable investments while limiting financial risks.

9. Green Banking Initiatives by Selected Indian Banks



Green Banking Initiatives by Indian Banks	
Bank	Initiative
SBI	Renewable Energy Financing & Green Channel Banking
HDFC BANK	Paperless Banking & Digital Transactions
ICICI Bank	Eco-Friendly Branch Operations
Punjab National Bank	Online Banking & Green Financial Services
AXIS BANK	Sustainable Investment Initiatives

Towards a Sustainable & Eco-Friendly Banking System

Pic. 3

SBI-Being a front runner when it comes to green channel banking and funding renewable energy sector, the institution has made it its top most priority to be a part of green economy shift.

HDFC Bank-being involved with digital transactions and paperless banking practices, the institution is slowly moving towards a paperless banking habit and an enhanced level of productivity.

ICICI Bank- with environmentally friendly branches, this institution has introduced the green approach to a basic day-to-day banking activity level.

Punjab National Bank-with growing focus on enhancing the green finance as well as online services, trying to instil a sense of habit in its customers to switch to a paperless environment.

Axis Bank-investing extensively on sustainable initiatives, supporting investments towards sustainable projects for future growth.

All the banks-Together, the banking institutions have shown us that sustainable practices are gaining ground at the national banking sector at an expansive scale.

The Future is Here- with continual development and enhancement of customer responsibilities would make

green banking a mandatory facet for the future of sustainable finance.

ESG-Based Banking Transformation

It seems like ESG factors are already an important part of how banks are working today, and have to be. Financial institutions need to judge borrowers based not just on their financial numbers but also on their environmental footprint, their social responsibilities, and their governance. Incorporating ESG increases transparency, builds trust with investors and can build long-term resilience within banks; banks working on this will be in a better position to help the economy and investment grow more sustainably.

10. Data Analysis and Interpretation

The primary data collected from **120 respondents** were analysed using descriptive statistical techniques, including percentage analysis, tabular presentation, and graphical representation. The analysis focuses on customers' awareness, adoption, and preferences regarding Green Banking 5.0 services. The findings provide valuable insights into the level of customer acceptance of environmentally sustainable banking practices in India. (18)

10.1 Awareness of Green Banking Services

Figure 4. Awareness Regarding Green Banking

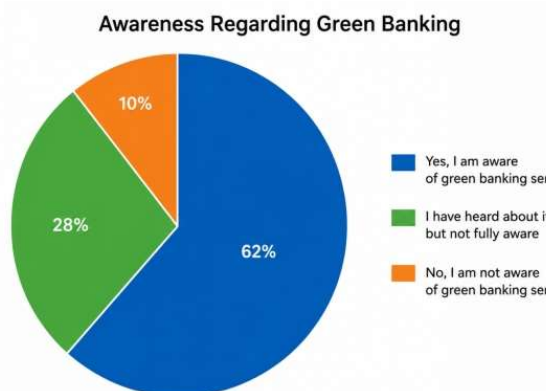


Figure 4. Awareness of Green Banking Services Source: Primary Survey (2026)

The results indicate that a majority of the respondents are aware of green banking services. The increasing adoption of smartphones, internet banking, and digital payment platforms has significantly improved customer awareness of environmentally sustainable banking practices. Government initiatives promoting digital financial inclusion and banks' continuous awareness campaigns have also contributed to the

Banking Method	Percentage
Digital Banking	69%
Traditional Banking	31%

growing acceptance of green banking services among customers. However, a small proportion of respondents still possess limited awareness, indicating the need for further educational and promotional initiatives by banks. (19)

10.2 Most Frequently Used Green Banking Services

Figure 5. Most Frequently Used Green Banking Services

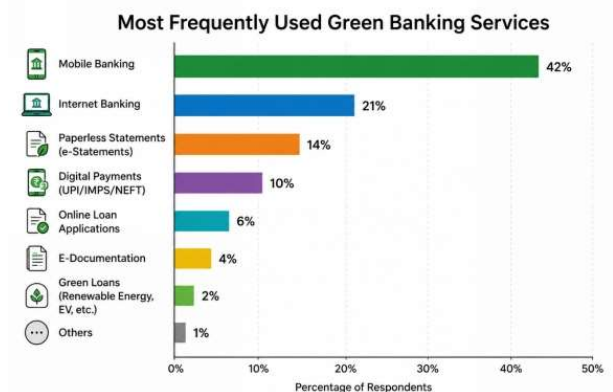


Figure 5.

The analysis reveals that **mobile banking** is the most frequently used green banking service among the respondents. Customers prefer mobile banking because it offers convenience, accessibility, real-time transaction facilities, and reduced dependency on physical bank branches. The increasing availability of smartphones, internet connectivity, and secure digital payment systems has further accelerated the adoption of mobile banking as an environmentally friendly banking solution. (20)

10.3 Preferred Banking Method

Table 1. Preferred Banking Method

Source: Primary Survey (2026)

Figure 6. Preferred Banking Method

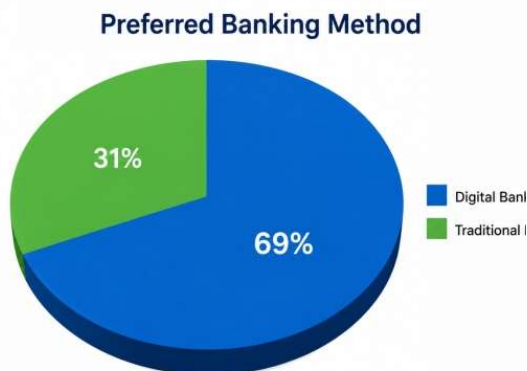


Figure 6.

The findings show that **69%** of the respondents prefer digital banking, whereas **31%** continue to use traditional banking methods. This indicates a clear shift toward digital banking due to its convenience, faster transaction processing, reduced paperwork, lower operational costs, and accessibility from any location. The increasing preference for digital banking also reflects customers' growing awareness of environmentally sustainable banking practices and their willingness to adopt paperless financial services. Nevertheless, the continued use of traditional banking by a section of customers suggests that further improvements in digital literacy, cybersecurity, and banking infrastructure are necessary to achieve wider adoption of Green Banking 5.0. (21)

10.4 Satisfaction Level with Green Banking Services

Figure 7. Satisfaction Level with Green Banking Services

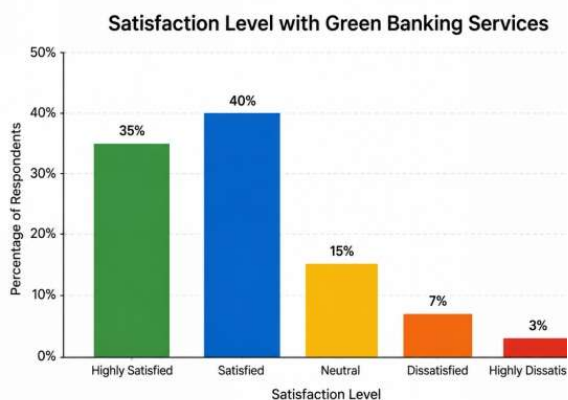


Figure 7.

The findings indicate that a majority of respondents are either **satisfied** or **highly satisfied** with green banking services. This high level of satisfaction reflects the convenience, accessibility, speed, and environmental benefits associated with digital banking platforms. A relatively small percentage of respondents expressed dissatisfaction, suggesting that

issues such as cybersecurity concerns, limited digital literacy, and internet connectivity continue to influence customer experience. Overall, the results demonstrate a positive customer perception of Green Banking 5.0 initiatives and indicate significant potential for the wider adoption of sustainable banking services in India. (23)

10.5 Summary of Data Analysis

The overall analysis demonstrates that customers exhibit a positive attitude toward green banking services, particularly digital and mobile banking. Higher levels of awareness and increased usage indicate that Green Banking 5.0 has significant potential to promote sustainable banking practices by reducing paper consumption, improving operational efficiency, and encouraging environmentally responsible financial behaviour. The findings further suggest that continuous technological innovation, customer awareness programmes, and supportive government policies will play a crucial role in expanding the adoption of Green Banking 5.0 in India. (22)

10.6 Hypothesis Testing

The Chi-square test was performed to examine the association between customer awareness and usage of Green Banking services.

The obtained p-value was less than 0.05.

Therefore, the null hypothesis was rejected.

This indicates that customer awareness significantly influences the adoption of Green Banking services.

11. Discussion

The Chi-square analysis also confirmed a statistically significant relationship between awareness and usage of Green Banking services. The findings of the present study indicate that customers have developed a positive attitude toward Green Banking 5.0 services, particularly digital and mobile banking. The high level of awareness observed among respondents suggests that the increasing adoption of smartphones, internet connectivity, and digital financial services has significantly improved customers' acceptance of environmentally sustainable banking practices. These findings are consistent with previous studies, which reported that digital transformation is one of the primary drivers of green banking adoption and sustainable financial development. (23)

The analysis further reveals that mobile banking is the most frequently used green banking service because of its convenience, accessibility, and time-saving features. The increasing preference for digital banking over traditional banking demonstrates a gradual shift toward paperless financial transactions, thereby reducing paper consumption and operational costs while supporting environmental sustainability. Similar observations have been reported in previous research on sustainable banking and digital finance. (24)

The study also supports the relevance of the proposed **Green Banking 5.0 Framework**, which integrates Artificial Intelligence (AI), ESG analytics, climate-risk assessment, and carbon-aware lending into banking operations. Although these technologies are still evolving within the Indian banking sector, their integration has the potential to improve credit appraisal, strengthen environmental risk management, and encourage responsible lending practices. The framework therefore extends the traditional concept of green banking by incorporating intelligent decision-support systems aligned with Industry 5.0 principles. (25)

Despite the growing acceptance of green banking, the study identifies several challenges that may hinder its widespread implementation. Cybersecurity risks, inadequate digital infrastructure, limited customer awareness in rural areas, and insufficient ESG data remain major barriers. Addressing these challenges through regulatory support, technological investment, and customer awareness programmes will be essential for strengthening sustainable banking practices in India. (26)

12. Practical and Environmental Implications

The implementation of Green Banking 5.0 provides significant benefits for banks, customers, policymakers, and the environment. The increasing adoption of digital banking services reduces paper consumption, electricity usage, transportation requirements, and operational costs while improving service efficiency. These improvements contribute directly to environmental sustainability and support India's commitment toward achieving low-carbon economic growth and sustainable development goals. (27)

The proposed Green Banking 5.0 framework also highlights the strategic importance of Artificial Intelligence, ESG analytics, climate-risk assessment, and carbon-aware lending in future banking operations. These technologies can assist financial institutions in improving lending decisions, identifying environmentally responsible investment opportunities, minimizing climate-related financial risks, and promoting sustainable business development. Consequently, Green Banking 5.0 has the potential to strengthen both financial resilience and environmental responsibility within the Indian banking sector. (28)

13. Challenges and Limitations

Although Green Banking 5.0 offers considerable opportunities, several challenges continue to affect its implementation. Limited awareness among rural customers, inadequate technological infrastructure, cybersecurity threats, high implementation costs, and dependence on traditional banking practices remain significant barriers. Furthermore, AI-enabled sustainable banking depends heavily on the availability of reliable ESG and environmental data, which remain insufficient in many developing economies. The absence of standardized ESG reporting frameworks also limits the

effectiveness of AI-driven sustainability assessment models. (29)

The present study has certain limitations. First, the analysis is based on responses from only **120 bank customers**, which may not fully represent the entire Indian banking population. Second, the study primarily focuses on urban and semi-urban respondents, limiting the generalization of findings to rural regions. Finally, the research adopts a descriptive analytical approach without advanced statistical modelling such as Structural Equation Modelling (SEM), suggesting opportunities for more comprehensive empirical investigations in future studies. (29)

14. Policy Recommendations

Based on the findings of the study, the following recommendations are proposed to strengthen Green Banking 5.0 implementation in India:

1. Banks should conduct regular awareness programmes to improve customer understanding of green banking services.
2. Digital banking infrastructure should be strengthened, particularly in rural and semi-urban regions.
3. Financial institutions should continuously enhance cybersecurity measures to improve customer confidence in digital banking.
4. Greater financial support should be provided for renewable energy and environmentally sustainable projects.
5. Nationwide financial literacy programmes should promote paperless and digital banking practices.
6. Regular training programmes should be organized for banking employees on sustainable finance and Green Banking 5.0 practices.
7. Banks should establish AI-based sustainability assessment systems for responsible lending decisions.
8. Standardized ESG reporting mechanisms should be implemented to improve sustainability assessment and regulatory compliance.
9. Climate-risk assessment should be incorporated into major lending and investment decisions.
10. Carbon-aware lending policies should be encouraged through appropriate regulatory guidelines and financial incentives. (30)

15. Key Findings

The major findings of the study are summarized as follows:

1. Customer awareness of green banking services has increased significantly due to digital transformation and financial inclusion initiatives.
2. Mobile banking is the most frequently used green banking service because of its convenience, accessibility, and efficiency.
3. Most respondents prefer digital banking over traditional banking methods.

4. Green banking contributes to reducing paper consumption, operational costs, and environmental impact.
5. Artificial Intelligence and ESG analytics have the potential to improve sustainable lending decisions.
6. Climate-risk assessment can strengthen environmental risk management within banking operations.
7. Carbon-aware lending can encourage environmentally responsible investments and support India's climate commitments.
8. Cybersecurity concerns, technological limitations, and inadequate ESG data remain major challenges for Green Banking 5.0 implementation.
9. The proposed Green Banking 5.0 framework provides an integrated approach for combining digital transformation with sustainable finance.
10. Green Banking 5.0 has significant potential to improve the long-term sustainability, resilience, and environmental performance of the Indian banking sector. (30)

16. Conclusion

The present study examined the adoption, awareness, and future potential of **Green Banking 5.0** in the Indian banking sector by integrating digital banking, Artificial Intelligence (AI), Environmental, Social and Governance (ESG) analytics, climate-risk assessment, and carbon-aware lending into a unified sustainable banking framework. The findings reveal that customers have developed a positive perception of green banking services, with digital and mobile banking emerging as the most preferred banking channels due to their convenience, accessibility, and environmental benefits. Increased awareness and the growing acceptance of paperless banking indicate that digital transformation is significantly contributing to sustainable banking practices in India. (31)

The study further demonstrates that Green Banking 5.0 extends the traditional concept of green banking by incorporating intelligent decision-support systems that enable banks to evaluate environmental, social, and climate-related risks alongside conventional financial indicators. The integration of AI, ESG analytics, climate-risk assessment, and carbon-aware lending has the potential to improve credit appraisal, strengthen risk management, encourage responsible investment, and support environmentally sustainable financial decision-making. These innovations are expected to play a vital role in helping the Indian banking sector achieve greater operational efficiency while contributing to national climate objectives and sustainable economic development. (32)

Despite these opportunities, the successful implementation of Green Banking 5.0 requires overcoming several challenges, including cybersecurity risks, inadequate technological infrastructure, limited customer awareness, insufficient ESG data availability, and the absence of standardized sustainability reporting frameworks. Addressing these challenges through regulatory support, technological investment, employee

training, and customer awareness programmes will be essential for strengthening sustainable banking practices across the country. (33)

Overall, the proposed Green Banking 5.0 framework provides a comprehensive and forward-looking approach to sustainable finance by combining digital transformation with environmental responsibility. The study contributes to the emerging literature on sustainable banking and offers practical guidance for banks, policymakers, regulators, and researchers seeking to promote environmentally responsible financial systems. Future research may validate the proposed framework using larger datasets, advanced statistical techniques, and comparative studies across different countries to further strengthen its practical applicability and academic contribution (34). The statistical analysis further validated that customer awareness plays an important role in increasing the adoption of Green Banking services.

17. Reference

1. Reserve Bank of India. (2024). *Annual Report 2023–24*. Mumbai: Reserve Bank of India.
2. Reserve Bank of India. (2024). *Report on Trend and Progress of Banking in India 2023–24*. Mumbai: Reserve Bank of India.
3. World Bank. (2023). *World Development Report 2023*. Washington, DC: World Bank.
4. International Finance Corporation. (2023). *IFC Annual Report 2023*. Washington, DC.
5. Bank for International Settlements. (2023). *Annual Economic Report 2023*. Basel, Switzerland.
6. Network for Greening the Financial System. (2023). *NGFS Annual Report 2023*. Paris.
7. United Nations Environment Programme Finance Initiative. (2023). *Annual Overview 2023*.
8. Organisation for Economic Co-operation and Development. (2023). *Green Finance and Investment Report*.
9. World Economic Forum. (2024). *The Global Risks Report 2024*. Geneva.
10. International Monetary Fund. (2023). *Global Financial Stability Report*. Washington, DC.
11. United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*.
12. United Nations. (2015). *Sustainable Development Goals (SDGs)*.
13. Reserve Bank of India. (2023). *Financial Stability Report*. Mumbai.
14. Reserve Bank of India. (2024). *Report on Currency and Finance*. Mumbai.
15. World Bank. (2022). *Global Financial Development Report*. Washington, DC.
16. International Energy Agency. (2023). *World Energy Outlook 2023*. Paris.
17. United Nations Development Programme. (2023). *Human Development Report*.
18. Asian Development Bank. (2023). *Asian Development Outlook*.

19. World Economic Forum. (2023). *Future of Jobs Report*.
20. Bank for International Settlements. (2022). *Climate-related Financial Risks*.
21. Reserve Bank of India. (2022). *Discussion Paper on Climate Risk and Sustainable Finance*.
22. International Finance Corporation. (2022). *Green Finance: A Bottom-up Approach to Track Existing Flows*.
23. United Nations Environment Programme Finance Initiative. (2022). *Banking on Sustainability*.
24. Network for Greening the Financial System. (2022). *Climate Scenarios for Central Banks and Supervisors*.
25. Organisation for Economic Co-operation and Development. (2022). *OECD Environmental Performance Reviews*.
26. World Bank. (2024). *World Development Indicators*.
27. International Monetary Fund. (2024). *World Economic Outlook*.
28. Reserve Bank of India. (2024). *Payments System Report*. Mumbai.
29. Bank for International Settlements. (2024). *Innovation Hub Annual Report*.
30. Network for Greening the Financial System. (2024). *Guide on Climate-related Data*.
31. Reserve Bank of India. (2024). *Report on Trend and Progress of Banking in India 2023–24*. Mumbai: Reserve Bank of India.
32. Network for Greening the Financial System. (2024). *NGFS Annual Report 2024*. Paris: NGFS
33. Bank for International Settlements. (2024). *Annual Economic Report 2024*. Basel, Switzerland: BIS.
34. World Bank. (2024). *World Development Report 2024: The Middle-Income Trap*. Washington, DC: World Bank.

Appendix A Questionnaire

Title: *Questionnaire on Customer Awareness and Adoption of Green Banking 5.0 Services in India*

Instructions to Respondents

The purpose of this questionnaire is to collect information regarding customers' awareness, perception, and adoption of Green Banking 5.0 services in India. The information provided by the respondents will be used solely for academic research purposes. All responses will remain confidential and anonymous.

Section A: Demographic Information

1. Gender

- ☐ Male
- ☐ Female
- ☐ Other

2. Age Group

- ☐ Below 25 Years
- ☐ 25–35 Years
- ☐ 36–45 Years
- ☐ 46–55 Years

- ☐ Above 55 Years

3. Educational Qualification

- ☐ Higher Secondary
- ☐ Graduate
- ☐ Postgraduate
- ☐ Doctorate
- ☐ Other

4. Occupation

- ☐ Government Employee
- ☐ Private Employee
- ☐ Business
- ☐ Student
- ☐ Self-employed
- ☐ Other

5. Area of Residence

- ☐ Urban
- ☐ Semi-Urban
- ☐ Rural

Section B: Green Banking Awareness and Usage

6. Are you aware of Green Banking services?

- ☐ Yes
- ☐ No

7. Which Green Banking services do you use most frequently?

- ☐ Internet Banking
- ☐ Mobile Banking
- ☐ ATM Services
- ☐ UPI/Digital Payments
- ☐ E-Statements

8. How often do you use Digital Banking services?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Rarely

9. Which banking method do you prefer?

- ☐ Digital Banking
- ☐ Traditional Banking

10. Are you satisfied with Green Banking services?

- ☐ Highly Satisfied
- ☐ Satisfied
- ☐ Neutral
- ☐ Dissatisfied
- ☐ Highly Dissatisfied

Section C: Perception of Green Banking 5.0

11. Do you believe Green Banking helps in environmental protection?

- ☐ Yes
- ☐ No
- ☐ Not Sure

12. Do you think Artificial Intelligence (AI) can improve banking services?

- ☐ Yes
- ☐ No

- ☐ Not Sure
- 13. Do you support AI-based Green Banking for future banking services?**
- ☐ Yes
- ☐ No
- ☐ Not Sure
- 14. Do you think banks should consider ESG (Environmental, Social and Governance) factors before approving loans?**
- ☐ Yes
- ☐ No
- ☐ Not Sure
- 15. Should banks include climate-risk assessment in lending decisions?**
- ☐ Yes
- ☐ No
- ☐ Not Sure

Section D: Rating Scale

Please indicate your level of agreement with the following statements using the scale below:

**1 = Strongly Disagree 2 = Disagree 3 = Neutral
4 = Agree 5 = Strongly Agree**

Statement	1	2	3	4	5
I am aware of Green Banking services.	☐	☐	☐	☐	☐
Digital Banking reduces paper consumption.	☐	☐	☐	☐	☐
Green Banking improves environmental sustainability.	☐	☐	☐	☐	☐
AI can improve sustainable banking decisions.	☐	☐	☐	☐	☐
I am willing to use Green Banking services regularly.	☐	☐	☐	☐	☐

Thank You

Thank you for your valuable participation in this survey. Your responses are highly appreciated and will contribute to academic research on **Green Banking 5.0**, sustainable finance, and AI-enabled banking practices in India.