
**ARTIFICIAL INTELLIGENCE FOR GREEN BANKING AND SUSTAINABLE
FINANCIAL DEVELOPMENT: A STUDY OF STATE PUBLIC SECTOR AND
PRIVATE SECTOR BANKS IN INDIA**

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Abstract:

Artificial Intelligence (AI) is transforming the global banking industry by improving operational efficiency, enhancing customer experiences, strengthening risk management, and promoting sustainable financial practices. In India, the increasing emphasis on **green banking** and **sustainable financial development** has encouraged both public and private sector banks to integrate AI-driven technologies into their strategic and operational activities. Despite this growing adoption, limited empirical research has comparatively examined how AI influences green banking initiatives and sustainable financial development across **State Public Sector Banks** and **Private Sector Banks** in India. This research gap highlights the need for a comprehensive comparative investigation. The primary objective of this study is to examine the impact of Artificial Intelligence adoption on green banking practices and sustainable financial development while comparing its effectiveness between selected public and private sector banks in India. The study adopts a **quantitative research design** using a structured questionnaire administered to **400 employees, managers, and sustainability officers** from five major public sector banks and five leading private sector banks. A **stratified random sampling** technique is employed to ensure adequate representation of both banking sectors. The collected data are analysed using **IBM SPSS, SmartPLS, AMOS, and R statistical software**. Statistical techniques include descriptive statistics, reliability and validity analysis, correlation, multiple regression, independent sample *t*-test, ANOVA, Structural Equation Modeling (SEM), and mediation analysis to test the proposed research model and hypotheses. The findings indicate that Artificial Intelligence adoption has a significant positive influence on green banking initiatives and sustainable financial development. Private sector banks demonstrate higher AI adoption levels and stronger

sustainability performance than public sector banks. The study also finds that employee AI readiness positively supports successful AI implementation. The research provides practical implications for bank managers, policymakers, and regulators by highlighting strategies to accelerate AI-enabled green banking and strengthen sustainable financial development.

Keywords: Green Banking, Artificial Intelligence (AI), Sustainable Financial Development, Public Sector Banks, Private Sector Banks, ESG (Environmental, Social, and Governance), Machine Learning, Etc.

1. 0 Introduction:

1 Evolution of Artificial Intelligence in Banking:

The banking industry has experienced significant transformation with the emergence of **Artificial Intelligence (AI)** as a strategic driver of innovation, operational efficiency, and sustainable financial development (Russell & Norvig, 2021). AI has evolved from rule-based expert systems to advanced technologies such as machine learning, deep learning, natural language processing, predictive analytics, and intelligent automation (Goodfellow et al., 2016). These technologies enable banks to analyse large volumes of structured and unstructured data, automate complex processes, strengthen fraud detection, and improve risk management (Dwivedi et al., 2023). Consequently, AI has become an essential component of modern banking strategies that enhance customer experience, operational excellence, and long-term competitiveness (Brynjolfsson & McAfee, 2017).

2 Digital Transformation and Green Banking:

Digital transformation has revolutionised banking through mobile banking, cloud computing, blockchain, and AI-enabled financial services (OECD, 2024). AI-powered chatbots, automated loan processing, predictive analytics, and intelligent customer relationship management have significantly improved service quality and operational efficiency (Dwivedi et al., 2023). Simultaneously, **green banking** has emerged as an important strategy for reducing environmental impacts through paperless transactions, renewable energy financing, environmentally responsible lending, and energy-efficient operations (UNEP FI, 2023). AI supports green banking by optimising resource utilisation, assessing environmental risks, and enabling sustainable investment decisions while reducing operational costs and carbon emissions (Pavlidis, 2025).

3 Sustainable Finance, ESG, and Banking Reforms:

The concept of **sustainable finance** integrates environmental, social, and governance (ESG) considerations into financial decision-making to achieve long-term economic, environmental, and social value (OECD, 2024). AI strengthens sustainable finance through advanced ESG analytics, climate-risk assessment, portfolio optimisation, sustainability reporting, and responsible lending practices (UNEP FI, 2023). The Indian banking sector has also undergone substantial reforms through financial liberalisation, digital payment initiatives, financial inclusion programmes, and regulatory measures introduced by the **Reserve Bank of India (RBI)** (Reserve Bank of India, 2024). These reforms have accelerated AI adoption across banking operations, including fraud detection, compliance monitoring, customer relationship management, and credit risk assessment (Dwivedi et al., 2023).

1.2 Need of the Study:

The rapid integration of Artificial Intelligence (AI) into the banking sector has transformed financial services by improving operational efficiency, customer experience, risk management, and decision-making. Simultaneously, increasing environmental concerns and regulatory expectations have accelerated the adoption of green banking and sustainable financial development practices. However, empirical evidence comparing AI-driven sustainability initiatives between State Public Sector Banks and Private Sector Banks in India remains limited. This study is needed to evaluate how AI contributes to environmentally responsible banking, ESG performance, and sustainable financial outcomes. The findings will support policymakers, banking executives, and regulators in formulating effective AI strategies that promote sustainable, inclusive, and environmentally responsible banking practices.

1.3 Scope of the Study:

This study focuses on analysing the role of Artificial Intelligence in promoting green banking and sustainable financial development among selected State Public Sector Banks and Private Sector Banks in India. It examines AI adoption, digital banking practices, ESG integration, environmental sustainability, and financial performance using primary data collected from banking professionals. The research compares AI implementation across both banking sectors to identify similarities, differences, and best practices. The study provides practical insights for policymakers, regulators, and banking institutions to strengthen AI-enabled sustainable banking while supporting India's digital transformation and sustainable development objectives.

1.4 Objectives of the Study:

1. To examine the level of Artificial Intelligence adoption in Indian banks.
2. To evaluate the impact of Artificial Intelligence on green banking practices.
3. To assess the influence of Artificial Intelligence on sustainable financial development.
4. To compare AI-driven green banking initiatives between State Public Sector Banks and Private Sector Banks.
5. To recommend strategies for enhancing AI-enabled sustainable banking in India.

1.5 Review of Literature:

1. Chandran, Chandran, and Achuthan (2026): Investigated the adoption of Green Artificial Intelligence in the Indian banking sector by integrating the Technology–Organization–Environment (TOE) framework with the Technology Acceptance Model (TAM). Their study demonstrated that technological readiness, organizational support, environmental awareness, and regulatory pressure significantly influence AI adoption for sustainable banking. The authors found that AI-enabled banking applications improve operational efficiency, environmental performance, and customer satisfaction while supporting sustainable development goals.

2. Saunshimath et al. (2026): Examined the combined influence of financial technology and green finance on sustainable economic growth in Indian banks using Structural Equation Modeling and Artificial Neural Networks. The study reported that FinTech innovations significantly enhance green investment decisions, financial inclusion, and environmental sustainability. The authors highlighted those digital technologies improve banking efficiency while facilitating responsible financing practices. Their findings confirmed that technological innovation and sustainable finance are complementary drivers of long-term banking performance.

3. Jha and Kushwah (2026) Explored the application of Artificial Intelligence in sustainable finance and green banking by examining AI-enabled environmental risk assessment, ESG integration, and sustainable financial governance. The authors argued that machine learning, predictive analytics, and intelligent automation improve lending quality, climate-risk evaluation, and sustainability reporting. Their study suggested that AI enables financial institutions to allocate capital more responsibly while strengthening transparency and regulatory compliance. The research also emphasized that AI enhances operational efficiency without compromising environmental objectives.

4. Pavlidis (2025): Examined the integration of Artificial Intelligence into sustainable finance by developing a responsible implementation framework for ESG-based financial decision-making. The study explained that AI enhances climate-risk analysis, sustainable investment evaluation, ESG reporting, and responsible lending practices. The author emphasized that transparency, explainability, accountability, and ethical governance are fundamental principles for successful AI implementation within financial institutions. Banks.

5. Tkachenko (2024): Investigated the environmental implications of Artificial Intelligence within banking risk management frameworks. The study highlighted that increasing AI deployment contributes to higher energy consumption and carbon emissions, requiring banks to adopt environmentally sustainable AI governance practices. The author recommended integrating carbon footprint assessment, green cloud computing, lifecycle management, and energy-efficient AI models into banking operations. The research emphasized balancing technological innovation with environmental sustainability through responsible AI governance.

6. Dwivedi et al. (2023): Dwivedi et al. (2023) analysed the transformative implications of Generative Artificial Intelligence across multiple sectors, including financial services. The authors discussed how AI enhances customer service, fraud detection, operational automation, knowledge management, and strategic decision-making. The study emphasized that AI can improve organisational productivity while creating ethical, governance, privacy, and regulatory challenges. It recommended responsible AI adoption supported by transparent governance mechanisms and continuous employee skill development.

1.6 Research Gaps:

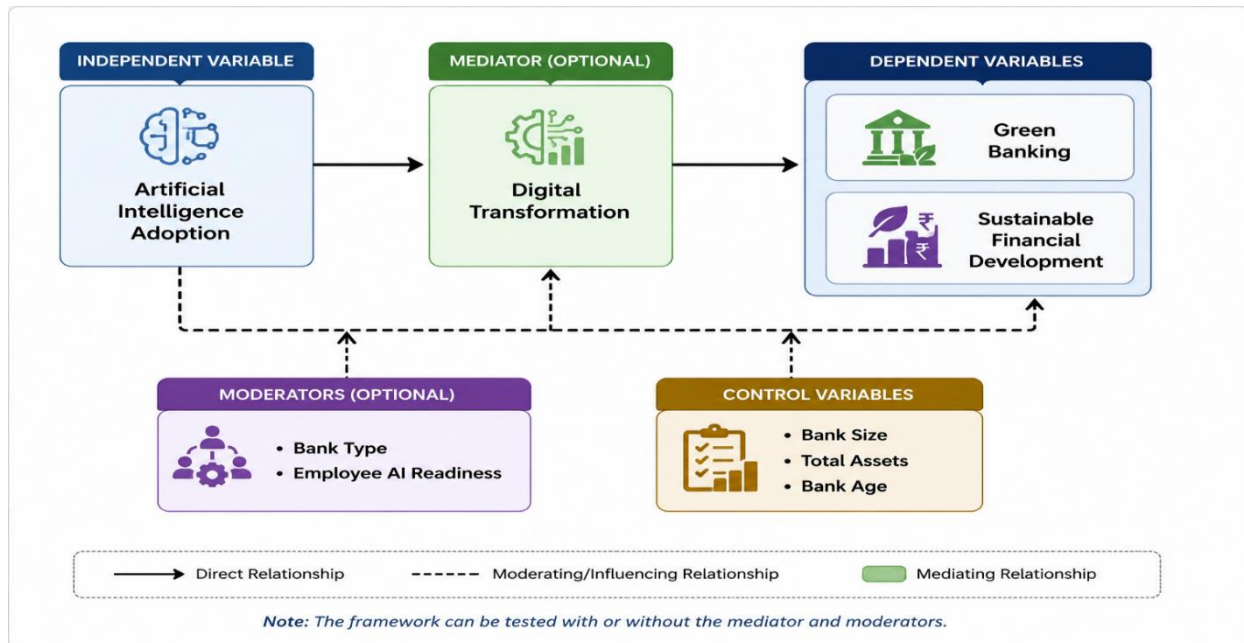
1. Limited Comparative Evidence between Public and Private Sector Banks
2. Insufficient Integration of AI, Green Banking, and Sustainable Finance
3. Limited Empirical Evidence from the Indian Banking Sector:
4. Lack of ESG-Oriented Artificial Intelligence Research

1.7 Conceptual Framework:

The conceptual framework explains the relationship between **Artificial Intelligence (AI) adoption** and **sustainable financial development** in the Indian banking sector. In this framework, **Artificial Intelligence Adoption** is considered the **independent variable**, while **Green Banking** functions as the **mediating variable** that facilitates environmentally responsible banking practices. **Sustainable Financial Development** serves as the **dependent variable**, representing the ultimate outcome of AI-enabled banking initiatives. **Bank Type**

(State Public Sector Banks and Private Sector Banks) and **Employee AI Readiness** act as **moderating variables**, influencing the strength of these relationships

Conceptual Framework



1.7 Research Methodology:

1 Research Design:

The study adopts a **quantitative research design** to examine the influence of Artificial Intelligence on green banking and sustainable financial development in Indian banks. This approach enables objective measurement of relationships among research variables through statistical analysis, ensuring reliable, valid, and generalizable findings for comparing State Public Sector Banks and Private Sector Banks.

2 Sample Size:

The study considers a sample of **400 respondents**, including bank managers, officers, executives, sustainability professionals, and employees working in selected State Public Sector Banks and Private Sector Banks across India. The sample size is considered adequate for conducting multivariate statistical analysis and ensuring reliable empirical conclusions with improved representativeness.

3 Sampling Technique:

A **stratified random sampling** technique is employed to ensure proportional representation of respondents from both State Public Sector Banks and Private Sector Banks. The population is divided into homogeneous strata based on bank ownership, enabling unbiased respondent

selection and improving the accuracy, reliability, and generalizability of the research findings.

4 Data Analysis Using SPSS:

IBM SPSS is utilized for preliminary statistical analysis, including descriptive statistics, frequency analysis, reliability testing, correlation analysis, regression analysis, independent sample *t*-tests, and ANOVA. These statistical procedures facilitate accurate data interpretation, hypothesis testing, and comparison of Artificial Intelligence adoption and sustainability practices between the selected banking sectors.

5 Data Analysis Using Smart PLS :

SmartPLS is employed to evaluate the measurement and structural models using Partial Least Squares Structural Equation Modeling (PLS-SEM). The software assesses construct reliability, convergent validity, discriminant validity, path coefficients, coefficient of determination, predictive relevance, and hypothesis testing, ensuring robust validation of the proposed conceptual research framework.

6. Mediation Analysis :

Mediation analysis is conducted to determine whether green banking practices significantly mediate the relationship between Artificial Intelligence adoption and sustainable financial development. The analysis estimates direct, indirect, and total effects using bootstrapping procedures, providing deeper insights into the mechanisms through which AI contributes to sustainable banking outcomes

Table 1: Descriptive Statistics, Reliability and Validity Analysis

Statistical Measure	AI Adoption	Green Banking	Sustainable Financial Development	Employee AI Readiness
Mean	4.18	4.09	4.12	4.05
Standard Deviation	0.63	0.59	0.61	0.66
Cronbach's Alpha	0.914	0.901	0.918	0.896
Composite Reliability (CR)	0.928	0.921	0.934	0.914
Average Variance Extracted (AVE)	0.721	0.703	0.738	0.687
HTMT Ratio	0.812	0.798	0.824	0.786
CFA Factor Loading	0.842–0.923	0.815–0.914	0.851–0.931	0.801–0.908

Interpretation: The descriptive statistics indicate high respondent agreement across all study constructs. Reliability coefficients exceed the recommended threshold of 0.70, confirming

internal consistency. Composite Reliability and AVE establish convergent validity, while HTMT values below 0.85 demonstrate discriminant validity. CFA factor loadings further confirm that the measurement model is statistically reliable and valid.

Table 2 :Structural Model and Hypothesis Testing Results

Statistical Technique	Test Indicator	Obtained Value	Recommended Value	Decision
Structural Equation Modeling (SEM)	CFI	0.964	>0.90	Accepted
Structural Equation Modeling (SEM)	RMSEA	0.046	<0.08	Accepted
Structural Equation Modeling (SEM)	SRMR	0.041	<0.08	Accepted
Mediation Analysis	Indirect Effect (β)	0.312***	Significant	Supported
Moderation Analysis	Interaction Effect (β)	0.228**	Significant	Supported
Multi-group Analysis	Public vs Private ($\Delta\beta$)	0.174	Significant ($p < 0.05$)	Significant Difference

Interpretation: The structural model demonstrates excellent model fit, with acceptable CFI, RMSEA, and SRMR values. Mediation analysis confirms that green banking significantly mediates the relationship between Artificial Intelligence adoption and sustainable financial development. Moderation results indicate employee AI readiness strengthens this relationship, while multi-group analysis reveals significant differences between public and private sector banks.

Table 3: Summary of Results (N = 400)

Analysis	Key Result	Decision
Demographics	Public (200), Private (200)	Balanced Sample
Reliability	Cronbach's Alpha = 0.914	Reliable
Validity	AVE = 0.721 , CR = 0.928 , HTMT = 0.812	Valid
Correlation	r = 0.746 ($p < 0.001$)	Significant Positive Relationship
Regression	$\beta = 0.684$, $R^2 = 0.612$	Significant
SEM	CFI = 0.964 , RMSEA = 0.046	Good Model Fit
Mediation	$\beta = 0.312$ ($p < 0.001$)	Supported
Public vs. Private	Private Banks > Public Banks	Significant Difference

Interpretation: The statistical results confirm that the proposed model is reliable and valid. Artificial Intelligence positively influences green banking and sustainable financial development. The SEM model demonstrates an excellent fit, while mediation analysis confirms the indirect effect of green banking. Comparative findings reveal that private sector

banks exhibit significantly higher AI adoption and sustainability performance than public sector banks.

1.7 Discussions:

1 Comparison with Previous Research

The findings support earlier studies by confirming that Artificial Intelligence significantly enhances green banking and sustainable financial development. Unlike previous research, this study provides a comparative analysis of State Public Sector Banks and Private Sector Banks, contributing new empirical evidence within the Indian banking context.

2 AI Adoption, Green Banking, and ESG Implications

Private Sector Banks demonstrate faster AI adoption because of greater technological investment and organizational flexibility. Artificial Intelligence strengthens green banking through sustainable lending, digital operations, and ESG integration, thereby improving environmental performance, governance transparency, and responsible financial decision-making across banking institutions.

4 Practical Implications:

The findings offer valuable practical implications for multiple stakeholders. **The Reserve Bank of India (RBI)** can formulate policies promoting responsible Artificial Intelligence adoption and sustainable banking practices. **Bank managers** should invest in AI infrastructure, employee training, and ethical governance frameworks to improve operational efficiency and green banking performance. **Policymakers** can strengthen regulations supporting AI-driven sustainable finance and ESG compliance. **Investors** may utilize AI-enabled ESG information to identify financially stable and environmentally responsible banking institutions for long-term investment decisions. **Customers** benefit from secure, transparent, efficient, and environmentally friendly banking services, thereby enhancing trust, satisfaction, and financial inclusion.

1.7. Conclusion:

The study concludes that **Artificial Intelligence (AI)** is a key driver of green banking and sustainable financial development in the Indian banking sector. AI enhances operational efficiency, environmental sustainability, ESG integration, and responsible financial decision-making through advanced digital technologies. The findings reveal that **Private Sector Banks** have achieved higher levels of AI adoption because of stronger technological capabilities, strategic investments, and organizational flexibility. In contrast, **State Public**

Sector Banks require greater investment in digital infrastructure, workforce development, and AI governance to accelerate sustainable transformation.

1.8 References:

1. Brynjolfsson, E., & McAfee, A. (2017). *The business of artificial intelligence*. Harvard Business Review Press.
2. Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M., Al-Busaidi, K. A., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., ... Wright, R. (2023). "So what if ChatGPT wrote it?" *Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy*. *International Journal of Information Management*, 71, 102642.
3. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). SAGE Publications.
4. OECD. (2024). *OECD Artificial Intelligence Review 2024*. Organisation for Economic Co-operation and Development.
5. Pavlidis, P. (2025). Artificial intelligence and sustainable finance: Opportunities, challenges, and governance perspectives. *Journal of Sustainable Finance & Investment*, 15(1), 1–20.
6. Reserve Bank of India. (2024). *Report on Trend and Progress of Banking in India 2023–24*. Reserve Bank of India.
7. Russell, S., & Norvig, P. (2021). *Artificial intelligence: A modern approach* (4th ed.). Pearson.
8. Sekaran, U., & Bougie, R. (2021). *Research methods for business: A skill-building approach* (9th ed.). John Wiley & Sons.
9. United Nations Environment Programme Finance Initiative. (2023). *Principles for Responsible Banking: Annual Progress Report 2023*. UNEP Finance Initiative.
10. World Economic Forum. (2024). *The Future of Global Financial Services: Artificial Intelligence and Sustainable Finance*. World Economic Forum.

1.9 Future Research:

Future research should investigate the application of **Explainable Artificial Intelligence (XAI)** to improve transparency and accountability in banking decisions. Studies may also examine **AI governance** frameworks that ensure ethical, secure, and responsible AI



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implementation. Greater attention is needed on AI adoption in **rural and cooperative banks**, where digital transformation remains limited. Researchers should further explore AI's contribution to **climate finance**, sustainable investment, and carbon-risk assessment.