"ARTIFICIAL INTELLIGENCE AS A SUPERVISORY TOOL FOR THE RESERVE BANK OF INDIA: A STUDY ON ENHANCING THE SUPERVISION OF PUBLIC SECTOR BANKS, PRIVATE SECTOR BANKS AND COOPERATIVE BANKS FOR IMPROVING ASSET QUALITY, PROFITABILITY, CYBER SECURITY AND OVERALL PERFORMANCE"

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Abstract: The rapid transformation of the global financial system through digital technologies has created both opportunities and challenges for banking supervision. Artificial Intelligence (AI) has emerged as a powerful technological tool capable of enhancing regulatory monitoring, risk assessment, fraud detection, cybersecurity management, and financial stability mechanisms. The Indian banking sector, consisting of Public Sector Banks (PSBs), Private Sector Banks, and Cooperative Banks, continues to face critical supervisory challenges, including non-performing assets (NPAs), profitability pressures, operational risks, cyber threats, and increasing financial complexities. This research proposes an Artificial Intelligence-Based Supervisory Framework for the Indian banking sector through a comparative analysis of the Reserve Bank of India (RBI) and selected global central banks.

The study examines the role of AI-driven supervisory practices in improving asset quality evaluation, profitability monitoring, cybersecurity resilience, and overall financial stability. It analyzes global regulatory experiences involving Supervisory Technology (SupTech), Regulatory Technology (RegTech), machine learning-based risk assessment, predictive analytics, automated compliance monitoring, and real-time supervisory systems. The research evaluates the applicability of these international practices within the Indian banking ecosystem while considering the diverse operational structures of public sector banks, private sector banks, and cooperative banking institutions.

The findings reveal that AI-based supervision can significantly improve early identification of credit risks, strengthen NPA prediction capabilities, enhance fraud detection mechanisms, optimize regulatory decision-making, and support proactive financial stability management. However, challenges related to data availability and quality, algorithmic transparency, cybersecurity vulnerabilities, regulatory preparedness, and technological infrastructure require systematic attention. Based on comparative insights, the study proposes an integrated AI-based supervisory framework for RBI incorporating predictive analytics, continuous risk monitoring, cybersecurity intelligence, and adaptive regulatory mechanisms.

The proposed framework aims to transform Indian banking supervision from a conventional compliance-oriented approach into a proactive, data-driven, and future-ready supervisory system. By responsibly integrating Artificial Intelligence into regulatory processes, the framework can enhance asset quality management, improve profitability assessment, strengthen cyber resilience, and contribute to sustainable financial stability in the evolving digital financial landscape.

Keywords: Artificial Intelligence, Banking Supervision, Reserve Bank of India, Global Central Banks, Supervisory Technology (SupTech), Regulatory Technology (RegTech), Public Sector Banks, Private Sector Banks, Cooperative Banks, Non-Performing Assets, Asset Quality, Profitability, Cybersecurity, Financial Stability, Predictive Analytics, Risk Management.

I. INTRODUCTION

The Indian banking sector is one of the largest and fastest-growing banking systems in the world. It plays a pivotal role in economic development by mobilizing savings, facilitating investments, promoting financial inclusion, and supporting industrial and agricultural growth. The Reserve Bank of India (RBI), established under the Reserve Bank of India Act, 1934, functions as the country's central bank and is entrusted with the responsibility of regulating and supervising banks to maintain monetary stability and financial soundness.

Over the last decade, the Indian banking industry has undergone a remarkable transformation. The rapid adoption of digital banking, Unified Payments Interface (UPI), internet banking, mobile banking, fintech innovations, cloud computing, and digital lending has significantly improved customer convenience and financial inclusion. Simultaneously, banks have become increasingly exposed to sophisticated cyber threats, digital frauds, operational risks, and technology-related vulnerabilities.

Between FY2020 and FY2025, the Indian banking sector experienced considerable improvement in financial health. Gross Non-Performing Assets (GNPAs) declined to multi-year lows, profitability reached record levels, capital adequacy improved, and banks became more resilient to economic shocks. These improvements were driven by regulatory reforms, enhanced provisioning, the Insolvency and Bankruptcy Code (IBC), better risk management practices, and strengthened supervisory oversight by the RBI.

Despite these achievements, the complexity of financial transactions has increased exponentially. Every day, Indian banks process billions of digital transactions across multiple platforms. Manual supervisory mechanisms, periodic inspections, and conventional data analysis are becoming insufficient to monitor such enormous volumes of financial information in real time. Consequently, supervisory authorities worldwide are increasingly adopting Artificial Intelligence, Machine Learning, Big Data Analytics, Supervisory Technology (SupTech), and Regulatory Technology (RegTech) to strengthen regulatory oversight.

Artificial Intelligence enables computers to perform cognitive functions such as learning from data, recognizing patterns, making predictions, and supporting decision-making with minimal human intervention. In banking supervision, AI can analyze millions of transactions within seconds, detect abnormal patterns, predict potential loan defaults, identify cyber threats, assess governance risks, monitor compliance, and generate early warning signals before financial problems escalate.

The Reserve Bank of India has already initiated several technology-driven supervisory reforms, including Risk-Based Supervision (RBS), the Central Repository of Information on Large Credits (CRILC), the Data Warehouse, the Central Fraud Registry, Supervisory Technology (SupTech), and the Public Tech Platform for Frictionless Credit. These initiatives provide a strong foundation for integrating Artificial Intelligence into banking supervision.

The application of AI in banking supervision extends beyond the detection of Non-Performing Assets. AI has the potential to transform supervisory processes by enabling continuous monitoring of liquidity, profitability, capital adequacy, cyber security, fraud risks, anti-money laundering compliance, consumer protection, operational resilience, and governance standards. Such intelligent supervision can significantly reduce systemic risks while improving the efficiency and transparency of the regulatory framework.

This research examines the role that Artificial Intelligence can play in strengthening the supervisory functions of the Reserve Bank of India. It specifically focuses on Scheduled Public Sector Banks, Private Sector Banks, and Cooperative Banks, analyzing their performance over the last five years and proposing an AI-driven supervisory framework to enhance financial stability and sustainable banking growth.

II. DEFINITIONS OF KEY CONCEPTS

2.1 Artificial Intelligence (AI)

Artificial Intelligence refers to the capability of computer systems to simulate human intelligence by learning from data, identifying patterns, making predictions, and performing decision-making tasks with minimal human intervention. AI encompasses Machine Learning, Deep Learning, Natural Language Processing (NLP), Computer Vision, and Expert Systems.

2.2 Machine Learning

Machine Learning is a subset of Artificial Intelligence that enables computers to learn from historical data without explicit programming and continuously improve prediction accuracy through experience.

2.3 Banking Supervision

Banking supervision refers to the continuous process through which the Reserve Bank of India monitors banks to ensure their financial soundness, regulatory compliance, operational stability, risk management, consumer protection, and systemic resilience.

2.4 Supervisory Technology (SupTech)

SupTech refers to the use of advanced technologies such as Artificial Intelligence, Big Data Analytics, Cloud Computing, and Machine Learning by regulatory authorities to improve supervisory efficiency and regulatory oversight.

2.5 Regulatory Technology (RegTech)

RegTech refers to technological solutions adopted by regulated entities to comply efficiently with regulatory requirements through automation, data analytics, and intelligent reporting systems.

2.6 Non-Performing Asset (NPA)

According to RBI guidelines, a Non-Performing Asset is a loan or advance where interest and/or principal remains overdue for more than 90 days.

NPAs are classified into:

- Standard Assets
- Sub-standard Assets
- Doubtful Assets
- Loss Assets

2.7 Gross Non-Performing Assets (GNPA)

Gross NPA represents the total value of loans classified as non-performing before adjusting provisions.

Formula

Gross NPA Ratio = (Gross NPAs ÷ Gross Advances) × 100

2.8 Net Non-Performing Assets (NNPA)

Net NPA represents Gross NPAs after deducting provisions made by banks.

Formula

Net NPA Ratio = (Net NPAs ÷ Net Advances) × 100

2.9 Cyber Security

Cyber Security refers to the protection of information systems, digital infrastructure, networks, banking applications, customer data, and financial transactions from unauthorized access, cyber attacks, ransomware, phishing, malware, identity theft, and data breaches.

2.10 Risk-Based Supervision (RBS)

Risk-Based Supervision is a supervisory framework adopted by the RBI in which supervisory resources are allocated based on the level of risk associated with each bank rather than applying uniform supervision to all institutions.

III. STATEMENT OF THE PROBLEM

The Indian banking sector has achieved significant progress in reducing Non-Performing Assets and improving profitability during the last five years. Nevertheless, the rapid expansion of digital banking has increased operational complexity, cyber risks, digital frauds, money laundering risks, and governance challenges. Traditional supervisory mechanisms largely depend upon periodic reporting, manual inspections, and post-event regulatory interventions, limiting the ability to detect emerging risks proactively.

The Reserve Bank of India currently receives enormous volumes of supervisory data from banks, including financial statements, regulatory returns, transaction reports, fraud reports, cyber incident reports, and compliance data. Manual analysis of such large datasets is increasingly challenging and may delay the identification of potential risks.

Artificial Intelligence provides an opportunity to transform banking supervision from reactive compliance monitoring to predictive, real-time supervision. However, there is limited empirical research examining how AI can be systematically integrated into RBI's supervisory framework while addressing asset quality, profitability, cyber security, governance, and operational resilience across Public Sector Banks, Private Sector Banks, and Cooperative Banks.

Therefore, the present study seeks to evaluate the effectiveness of Artificial Intelligence as a supervisory tool for the Reserve Bank of India and proposes a comprehensive AI-enabled supervisory framework for strengthening banking regulation in India.

IV. REVIEW OF LITERATURE

4.1 Arner, Barberis and Buckley (2017)

The authors introduced the concept of RegTech and SupTech, emphasizing the role of Artificial Intelligence and data analytics in improving regulatory compliance and supervisory efficiency. They argued that AI can significantly reduce compliance costs while enabling regulators to process large volumes of financial information more effectively.

4.2 Bank for International Settlements (2021)

The BIS highlighted that central banks worldwide are increasingly adopting SupTech solutions for real-time supervision, fraud detection, anti-money laundering monitoring, and predictive risk assessment. The report emphasized AI-driven supervisory dashboards and machine learning models for early warning systems.

4.3 Reserve Bank of India Annual Reports (2021–2025)

The RBI Annual Reports indicate substantial improvements in asset quality, profitability, capital adequacy, and banking resilience. The reports also emphasize increasing investments in technology, cyber security, digital supervision, and risk-based supervisory frameworks.

4.4 Financial Stability Reports (RBI)

The Financial Stability Reports consistently highlight cyber security, operational resilience, digital frauds, interconnected financial risks, and climate-related financial risks as emerging supervisory priorities requiring advanced analytical capabilities.

4.5 World Bank (2022)

The World Bank observed that Artificial Intelligence improves financial inclusion, enhances credit assessment, strengthens fraud detection, and enables regulators to identify systemic financial risks more effectively through predictive analytics.

4.6 International Monetary Fund (2023)

The IMF emphasized that AI can improve financial supervision through automated monitoring, stress testing, macroprudential surveillance, and systemic risk analysis. However, it also cautioned against algorithmic bias, governance challenges, and cybersecurity risks associated with AI deployment.

4.7 Basel Committee on Banking Supervision

The Basel Committee has emphasized stronger governance, model risk management, operational resilience, and the responsible use of advanced technologies in banking supervision. It recommends that AI applications be explainable, transparent, and subject to effective human oversight.

V. RESEARCH GAP

Existing literature primarily focuses on the application of Artificial Intelligence by commercial banks for customer service, credit scoring, fraud detection, and operational efficiency. Comparatively fewer studies examine AI from the perspective of the central bank as a supervisory authority.

The available research does not adequately address:

1. AI-based supervision of Scheduled Public Sector Banks, Private Sector Banks, and Cooperative Banks under a unified framework.
2. Integration of AI with RBI's existing Risk-Based Supervision and SupTech initiatives.
3. AI-enabled predictive monitoring of NPAs, profitability, governance, and cyber security.
4. Comparative supervisory requirements of different categories of banks.
5. A comprehensive AI architecture specifically designed for the Reserve Bank of India.

The present study attempts to bridge these gaps by proposing an integrated AI-enabled supervisory model tailored to the Indian banking ecosystem.

VI. OBJECTIVES OF THE STUDY

The study has the following objectives:

1. To examine the present supervisory framework adopted by the Reserve Bank of India.
2. To analyze the performance of Scheduled Public Sector Banks, Private Sector Banks, and Cooperative Banks during FY2020–FY2025.
3. To evaluate trends in Gross NPAs, Net NPAs, profitability, capital adequacy, and cyber security.
4. To assess the role of Artificial Intelligence in strengthening banking supervision.
5. To identify AI applications for predictive NPA management, fraud detection, cyber risk monitoring, and governance assessment.
6. To propose an AI-enabled supervisory framework for the Reserve Bank of India.
7. To provide policy recommendations for improving banking supervision using Artificial Intelligence

VII. RESEARCH METHODOLOGY

The present study adopts a **descriptive, analytical, and exploratory research design**.

7.1 Nature of Research

- Descriptive
- Analytical
- Exploratory

7.2 Sources of Data

The study is based exclusively on secondary data collected from:

- Reserve Bank of India Annual Reports (2020–2025)
- Financial Stability Reports
- RBI Master Directions and Circulars
- Ministry of Finance publications
- Government of India reports
- Annual reports of Scheduled Commercial Banks
- Bank for International Settlements (BIS)
- International Monetary Fund (IMF)
- World Bank
- Basel Committee publications
- Research journals
- Books
- Research papers

7.3 Period of Study

The study covers the period from **Financial Year 2020 to Financial Year 2025**.

7.4 Tools Used

- Comparative analysis
- Trend analysis
- Ratio analysis
- Descriptive statistics
- Graphical representation
- Conceptual AI framework
- Policy analysis

7.5 Scope of the Study

The study is confined to:

- Scheduled Public Sector Banks
- Scheduled Private Sector Banks
- Urban Cooperative Banks
- RBI supervisory framework
- AI applications in banking supervision
- NPAs, profitability, cyber security, governance, and operational resilience

VIII. RESERVE BANK OF INDIA GUIDELINES & REGULATORY FRAMEWORK FOR BANKING SUPERVISION

The Reserve Bank of India (RBI), established under the **Reserve Bank of India Act, 1934**, is the apex monetary authority responsible for regulating and supervising banks in India. The Banking Regulation Act, 1949 empowers the RBI to license banks, prescribe prudential norms, inspect banking companies, issue directions, and ensure financial stability. Over the last decade, and particularly during FY2020–FY2025, the RBI has significantly strengthened its supervisory architecture by incorporating technology, data analytics, and risk-based approaches.

8.1 Risk-Based Supervision (RBS)

The RBI introduced **Risk-Based Supervision (RBS)** to shift from compliance-oriented supervision to risk-focused oversight. Instead of treating all banks alike, RBS allocates supervisory attention based on the inherent risk profile of each bank.

The principal objectives of RBS include:

- Identification of emerging risks before they become systemic.
- Efficient allocation of supervisory resources.
- Continuous monitoring of financial soundness.
- Assessment of governance, capital adequacy, liquidity, operational resilience, and compliance.
- Prevention of banking crises through early intervention.

Artificial Intelligence can significantly strengthen RBS by providing real-time risk scores based on continuously updated financial and operational data.

8.2 Supervisory Technology (SupTech)

Recognizing the exponential growth of banking data, the RBI has increasingly adopted **Supervisory Technology (SupTech)**. SupTech enables regulators to automate data collection, validate regulatory returns, detect anomalies, and generate supervisory alerts.

AI can further enhance SupTech by:

- Automatically identifying abnormal financial trends.
- Predicting deterioration in asset quality.
- Ranking banks according to supervisory risk.
- Generating automated inspection reports.
- Monitoring compliance continuously rather than periodically.

8.3 Prompt Corrective Action (PCA) Framework

The RBI's **Prompt Corrective Action (PCA)** framework is designed to restore the financial health of weak banks before their condition becomes critical.

Banks are monitored based on:

- Capital Adequacy Ratio (CRAR)
- Net NPA Ratio
- Return on Assets (RoA)
- Leverage Ratio

AI-based predictive models could identify banks likely to breach PCA thresholds several months in advance, enabling earlier supervisory intervention.

8.4 Prudential Norms for Income Recognition, Asset Classification and Provisioning (IRACP)

The RBI has prescribed comprehensive norms governing:

- Income Recognition
- Asset Classification
- Loan Provisioning
- NPA Identification
- Restructured Accounts

Artificial Intelligence can examine millions of loan accounts simultaneously to identify:

- Hidden stress.
- Loan evergreening.
- Delayed recognition of NPAs.
- Incorrect asset classification.
- Under-provisioning.

8.5 Central Repository of Information on Large Credits (CRILC)

CRILC is a centralized database containing information regarding borrowers with aggregate exposure above prescribed thresholds.

AI can enhance CRILC by:

- Predicting borrower distress.
- Detecting interconnected defaults.
- Identifying industry-wide stress.
- Monitoring concentration risks.
- Detecting group exposure patterns.

8.6 Fraud Monitoring Framework

The RBI has strengthened fraud reporting by introducing:

- Central Fraud Registry
- Early Warning Signals
- Red Flagged Accounts
- Special Monitoring of High-Value Frauds

AI applications can significantly improve fraud detection through:

- Pattern recognition.
- Behavioural analytics.
- Transaction monitoring.
- Network analysis.
- Machine learning algorithms.

8.7 Cyber Security Framework

The RBI has issued comprehensive cyber security guidelines requiring banks to implement:

- Security Operations Centres (SOC)
- Security Information and Event Management (SIEM)
- Incident Response Teams
- Cyber Crisis Management Plans

- Vulnerability Assessments
- Penetration Testing
- Board-approved Cyber Security Policies

AI strengthens cyber supervision through:

- Real-time intrusion detection.
- Malware detection.
- Ransomware identification.
- Insider threat monitoring.
- AI-enabled phishing detection.
- Behavioural authentication.

8.8 Digital Lending Guidelines

Recent RBI guidelines on digital lending emphasize:

- Transparency.
- Customer protection.
- Data privacy.
- Responsible lending.
- Fair recovery practices.

AI can continuously monitor digital lending portfolios to identify:

- Excessive borrower leverage.
- Predatory lending.
- Rapid loan concentration.
- Algorithmic discrimination.
- Compliance violations.

IX. GOVERNMENT OF INDIA INITIATIVES SUPPORTING AI-BASED BANKING SUPERVISION

The Government of India has undertaken several structural reforms that complement RBI's supervisory framework.

9.1 Insolvency and Bankruptcy Code (IBC), 2016

The IBC has transformed India's credit recovery ecosystem by providing time-bound insolvency resolution mechanisms.

Major benefits include:

- Faster recovery of stressed assets.
- Reduction in NPAs.
- Improved credit discipline.
- Better lending practices.

AI can identify borrowers likely to enter insolvency proceedings much earlier.

9.2 EASE Reforms (Enhanced Access and Service Excellence)

The Government introduced EASE reforms for Public Sector Banks to improve:

- Governance.
- Digital banking.
- Risk management.
- Credit monitoring.
- Customer service.
- Responsible banking.

AI aligns naturally with these objectives by enabling intelligent decision-making.

9.3 Digital India Mission

Digital India has accelerated:

- Online banking.
- UPI.
- Aadhaar authentication.
- Digital payments.
- Financial inclusion.

Consequently, banking supervision now requires AI-driven monitoring of billions of digital transactions.

9.4 Pradhan Mantri Jan Dhan Yojana

The PMJDY has significantly expanded financial inclusion.
With more than 500 million accounts opened, supervisory responsibilities have increased correspondingly. AI can monitor:

- Dormant accounts.
- Fraudulent activity.
- Account misuse.
- Unusual transaction behaviour.

9.5 Public Tech Platform for Frictionless Credit

The RBI-supported Public Tech Platform integrates multiple databases for digital credit assessment.
AI can leverage data from:

- GST Network.
- Income Tax.
- Aadhaar.
- DigiLocker.
- Credit Information Companies.
- Banking transactions.

This facilitates more accurate risk assessment.

9.6 Digital Personal Data Protection Act

AI-based supervision must comply with data protection principles, ensuring:

- Data confidentiality.
- Privacy.
- Consent management.
- Responsible AI governance.

X. OVERVIEW OF THE INDIAN BANKING SECTOR (FY 2020-FY 2025)

The Indian banking system consists of:

Category	Approximate Number
Public Sector Banks	12
Private Sector Banks	21
Small Finance Banks	12
Payments Banks	6
Foreign Banks	44
Urban Cooperative Banks	Approximately 1,450

The banking industry contributes significantly to:

- Economic growth.
- Industrial finance.
- MSME development.
- Agricultural credit.
- Infrastructure financing.
- Financial inclusion.

XI. COMPARATIVE PERFORMANCE OF BANKS DURING FY 2020 – FY 2025

The last five years have witnessed remarkable improvements in banking performance.

11.1 Gross NPA Ratio of Scheduled Commercial Banks

Financial Year	Gross NPA (%)
FY2020	8.2
FY2021	7.3
FY2022	5.9
FY2023	3.9
FY2024	2.7
FY2025*	Around 2.3–2.5

(*Based on RBI trends and provisional supervisory assessments.)

11.1.1 Interpretation

The Gross NPA ratio declined by nearly **70%** during five years, reflecting:

-
- Improved credit underwriting.
- Better recovery through IBC.
- Higher provisioning.
- Strong economic recovery.
- Enhanced RBI supervision.

11.2 Net NPA Ratio

Year	Net NPA (%)
FY2020	2.9
FY2021	2.4
FY2022	1.7
FY2023	1.0
FY2024	0.6
FY2025	Below 0.6

11.2.1 Analysis

Net NPAs have reached historic lows due to:

- Higher provisioning.
- Better recoveries.
- Improved risk management.
- Conservative lending.

11.3 Capital Adequacy Ratio (Scheduled Commercial Banks)

Year	CRAR (%)
FY2020	14.7
FY2021	16.0
FY2022	16.8
FY2023	17.2
FY2024	17.7
FY2025	Above 17.5

11.3.1 Analysis

The steady improvement demonstrates:

- Strong capital buffers.
- Regulatory compliance.
- Increased resilience.
- Lower systemic risk.

11.4 Profitability Trends

Year	Trend
FY2020	Moderate
FY2021	Recovery Begins
FY2022	Strong Growth
FY2023	Record Profits
FY2024	Highest Ever Profits
FY2025	Continued Strong Performance

Public Sector Banks collectively reported their highest-ever profits during FY2024 and maintained strong earnings in FY2025 due to:

- Declining NPAs.
- Lower provisioning costs.
- Higher Net Interest Margins.
- Growth in retail lending.
- Improved treasury income.

XII. COMPARATIVE ANALYSIS – PUBLIC SECTOR BANKS, PRIVATE SECTOR BANKS AND CO-OPERATIVE BANKS

Parameter	Public Sector Banks	Private Sector Banks	Cooperative Banks
Asset Quality	Improved significantly	Excellent	Moderate
Profitability	Record profits	Consistently high	Limited
Technology	Rapid improvement	Highly advanced	Moderate
AI Adoption	Moderate	High	Low
Cyber Security	Good	Excellent	Needs strengthening
Governance	Improved	Strong	Requires reforms
Digital Banking	Extensive	Extensive	Growing
Operational Efficiency	High	Very High	Moderate
Supervisory Risk	Moderate	Moderate	High

XIII. ANALYSIS OF THE COMPARATIVE PERFORMANCE

The comparative analysis reveals significant differences among the three categories of banks.

13.1 Public Sector Banks

Public Sector Banks have undergone a remarkable transformation after years of high NPAs.
Major improvements include:

- Significant reduction in stressed assets.
- Record profitability.
- Improved capital adequacy.
- Better governance.
- Greater digital adoption.

However, challenges remain in:

- Large corporate exposures.
- Legacy NPAs.
- Operational efficiency.
- AI adoption.

13.2 Private Sector Banks

Private Sector Banks continue to outperform in:

- Digital innovation.
- Customer service.
- Operational efficiency.
- AI implementation.
- Profitability.
- Risk management.

They remain vulnerable to:

- Cyber attacks.
- Digital fraud.
- Technology concentration risk.

13.3 Cooperative Banks

Cooperative Banks remain the most vulnerable segment due to:

- Weak governance.
- Limited technological infrastructure.
- Higher fraud risk.
- Poor cybersecurity preparedness.
- Concentrated lending.
- Resource constraints.

Consequently, Cooperative Banks require the greatest supervisory attention and stand to benefit the most from AI-enabled oversight.

XIV. COMPARATIVE STATEMENT OF CENTRAL BANKS OF DEVELOPED COUNTRIES USING ARTIFICIAL INTELLIGENCE (AI) FOR BANKING SUPERVISION

14.1 Central banks and financial regulators in developed economies have increasingly adopted **Artificial Intelligence (AI), Machine Learning (ML), Big Data Analytics, Natural Language Processing (NLP), and Supervisory Technology (SupTech)** to strengthen banking supervision. The objective is to move from traditional periodic inspections toward **continuous, predictive, data-driven supervision**.

major areas where AI is being applied internationally include:

- Early identification of banking risks.
- Predictive detection of Non-Performing Loans (NPLs).

- Cybersecurity monitoring.
- Fraud and Anti-Money Laundering (AML) surveillance.
- Regulatory compliance monitoring.
- Stress testing.
- Governance and operational risk assessment.
- Automated analysis of regulatory filings.

The following comparative statement examines how leading central banks and financial regulators of developed countries are using AI for banking supervision and the lessons that can be applied by the Reserve Bank of India (RBI).

14.2. Comparative Statement: AI Adoption by Global Central Banks for Banking Supervision –

Country	Central Bank / Regulator	AI / SupTech Initiatives	Areas of AI Application	Effectiveness / Outcomes	Lessons for RBI
United Kingdom	Bank of England and Prudential Regulation Authority (PRA)	Advanced SupTech programme, machine learning-based supervisory analytics, regulatory data transformation	Bank risk assessment, stress testing, regulatory reporting analysis, climate risk monitoring	Improved ability to analyse large volumes of regulatory data and identify emerging risks earlier	RBI can develop AI-based supervisory dashboards and predictive risk scoring systems
United States	Federal Reserve System, Office of the Comptroller of the Currency (OCC), Federal Deposit Insurance Corporation (FDIC)	AI and advanced analytics for supervision, anomaly detection, fraud monitoring	Bank examinations, fraud detection, AML monitoring, cyber risk analysis	Enhanced examination efficiency and identification of unusual banking activities	RBI can use AI to analyse CRILC, fraud databases, and transaction patterns
European Union	European Central Bank (ECB) and European banking supervisors	SupTech tools, machine learning models, natural language processing	Supervisory reporting, risk classification, thematic reviews, compliance monitoring	Reduced manual supervisory workload and improved consistency of assessments	RBI can apply NLP to analyse inspection reports, audit reports and compliance documents
Singapore	Monetary Authority of Singapore (MAS)	AI-driven SupTech and RegTech ecosystem, Project Ellipse	AML detection, suspicious transaction monitoring, regulatory reporting, cyber supervision	One of the world's most advanced AI-based regulatory ecosystems	RBI can develop integrated AI platforms linking banks, regulators and financial databases

Canada	Office of the Superintendent of Financial Institutions (OSFI) and Bank of Canada	Advanced analytics and AI-based risk monitoring	Financial stability monitoring, operational resilience, systemic risk analysis	Improved assessment of financial system vulnerabilities	RBI can strengthen macroprudential supervision through AI-based stress testing
Australia	Australian Prudential Regulation Authority (APRA)	Data-driven supervision and analytics platforms	Prudential reporting, risk assessment, governance monitoring	Faster identification of supervisory concerns	RBI can automate regulatory returns analysis
Japan	Bank of Japan and Financial Services Agency (FSA)	AI research programmes and data analytics adoption	Financial stability analysis, market surveillance, operational risk monitoring	Improved understanding of complex financial relationships	RBI can use AI for interconnected exposure analysis
South Korea	Financial Supervisory Service and Bank of Korea	AI-based financial monitoring systems	Fraud detection, financial consumer protection, risk monitoring	Faster detection of abnormal financial activity	Useful model for RBI's cooperative bank supervision
Switzerland	Swiss Financial Market Supervisory Authority (FINMA) and Swiss National Bank	Data analytics and technology-enabled supervision	Systemic risk monitoring, bank risk models, compliance supervision	Strengthened supervision of globally significant banks	RBI can adopt AI for large-bank supervision

14.3. Detailed Comparative Analysis

14. 3.1 United Kingdom – Bank of England

The United Kingdom is among the global leaders in adopting AI for financial supervision.

AI Applications:

(a) Supervisory Data Analytics

The Bank of England uses advanced analytics to:

- Examine regulatory returns.
- Identify unusual trends.
- Compare banks against peer institutions.
- Detect emerging vulnerabilities.

(b) Stress Testing

AI assists in:

- Scenario modelling.
- Capital adequacy assessment.

- Systemic risk analysis.

(c) Climate Risk Supervision

Machine learning models are used to assess:

- Climate-related financial risks.
- Sectoral vulnerabilities.
- Long-term banking resilience.

Relevance for RBI

India can adopt similar models for:

- NPA prediction.
- Sectoral credit risk monitoring.
- Climate-related banking risks.

14.3.2 United States – Federal Reserve

The Federal Reserve supervises some of the world's largest financial institutions and uses technology extensively.

AI Applications:

Fraud Detection

AI identifies:

- Unusual transaction patterns.
- Suspicious activities.
- Payment fraud.

Bank Examination

AI supports examiners by:

- Reviewing documents.
- Identifying risk indicators.
- Prioritizing supervisory attention.

Cyber Risk Management

AI tools monitor:

- Network vulnerabilities.
- Cyber incidents.
- Operational resilience.

Relevance for RBI

The Federal Reserve model demonstrates how AI can enhance human supervision rather than replace supervisors.

14.3.3 European Central Bank (ECB)

The ECB supervises significant European banks through the Single Supervisory Mechanism.

AI Applications:

Natural Language Processing

NLP is used to analyse:

- Bank disclosures.
- Risk reports.
- Audit observations.

- Supervisory documents.

Risk Classification
AI models help classify banks according to:
- Credit risk.
- Market risk.
- Operational risk.
- Governance risk.

Relevance for RBI
RBI can apply NLP to analyse:
- Bank inspection reports.
- Board meeting records.
- Statutory audit reports.
- Compliance submissions.

14.3.4 Singapore – Monetary Authority of Singapore (MAS)
Singapore represents one of the most advanced examples of AI-enabled financial regulation.

Project Ellipse
MAS developed Project Ellipse to integrate:
- Artificial Intelligence.
- Natural Language Processing.
- Big Data Analytics.

Applications:

AML Monitoring
AI identifies:
- Suspicious transactions.
- Money laundering networks.
- Cross-border financial crime.

Regulatory Reporting
AI reduces:
- Manual reporting burden.
- Compliance costs.
- Data inconsistencies.

Cyber Security
AI monitors:
- Digital threats.
- Operational resilience.
- Technology risks.

Relevance for RBI
MAS provides a strong model for developing an RBI AI Supervisory Platform.

14.3.5 Canada – OSFI
Canada focuses heavily on financial stability and operational resilience.
AI applications include:
- Systemic risk identification.

- Bank vulnerability assessment.
- Scenario modelling.
- Operational risk analysis.

Relevance for RBI

Useful for monitoring:

- Large Public Sector Banks.
- Systemically Important Banks.
- Interconnected exposures.

14.4. Comparative Effectiveness Analysis

Parameter	Developed Country Regulators	Present RBI Position	Future Requirement for RBI
AI-Based Risk Scoring	Highly developed	Emerging	Develop national banking risk score
Real-Time Supervision	Advanced	Partial	Continuous monitoring system
Predictive NPA Analysis	Widely used	Limited	AI-based early warning system
Cyber Risk Monitoring	Advanced	Improving	Central AI cyber intelligence platform
AML Detection	Mature	Improving	AI-based transaction network analysis
Regulatory Reporting Automation	Advanced	Developing	Complete automation
NLP-Based Document Analysis	Common	Limited	Required for inspection reports
AI Stress Testing	Advanced	Developing	Dynamic AI stress models
Cooperative Bank Supervision	Limited relevance	Major challenge	High priority area

14.5. Key Lessons for the Reserve Bank of India

Based on international experience, RBI can develop the following AI-based supervisory framework:

14.5.1. AI-Based National Banking Risk Index

Similar to models used by developed regulators, RBI should create a composite risk score incorporating:

- NPAs.
- Capital adequacy.
-
- Liquidity.
- Profitability.
- Cyber incidents.
- Governance indicators.

14.5.2. Central Supervisory Data Lake

The RBI should integrate:

- CRILC data.
- Banking transactions.
- Fraud databases.
- Cyber incident reports.

- Credit bureau information.
- GST and corporate information (subject to legal frameworks).

14.5.3. AI-Based NPA Prediction System

AI should predict:

- Borrower default probability.
- Sectoral stress.
- Bank-level credit risk.

14.5.4. AI Cyber Security Command Centre

A central AI platform should monitor:

- Cyber attacks.
- Digital frauds.
- Malware.
- Data breaches.

14.5.5. AI Supervision of Cooperative Banks

India's cooperative banking sector requires special attention. AI can provide:

- Automated surveillance.
- Fraud detection.
- Governance monitoring.
- Branch-level risk assessment.

14.5.6. Overall Comparative Observations -

The experience of developed countries demonstrates that Artificial Intelligence has become an essential component of modern banking supervision. The United Kingdom, United States, European Union, Singapore, Canada, Australia, Japan, and Switzerland have moved toward **predictive and continuous supervision** using AI and SupTech.

India has already created a strong foundation through RBI's Risk-Based Supervision framework, CRILC, Central Fraud Registry, digital banking infrastructure, and supervisory technology initiatives. However, compared with leading regulators such as MAS, Bank of England, and Federal Reserve, India's AI adoption in banking supervision remains at an emerging stage.

Given the size and complexity of India's banking system, especially the challenges faced by Public Sector Banks and Cooperative Banks, RBI should accelerate the development of an **AI-driven Supervisory Intelligence Platform**. Such a system would enable:

- Earlier detection of NPAs.
- Better control of fraud.
- Stronger cyber security.
- Improved governance monitoring.
- More efficient regulatory supervision.

The adoption of AI will enable RBI to evolve from a traditional supervisory institution into a **next-generation intelligent financial regulator capable of ensuring stability, transparency, and resilience in India's banking system.**

XV. ARTIFICIAL INTELLIGENCE AS A SUPERVISORY TOOL FOR THE RESERVE BANK OF INDIA

15.1 The Indian banking sector generates enormous volumes of financial and non-financial data every day. These include loan applications, customer transactions, digital payment records, treasury operations, cyber

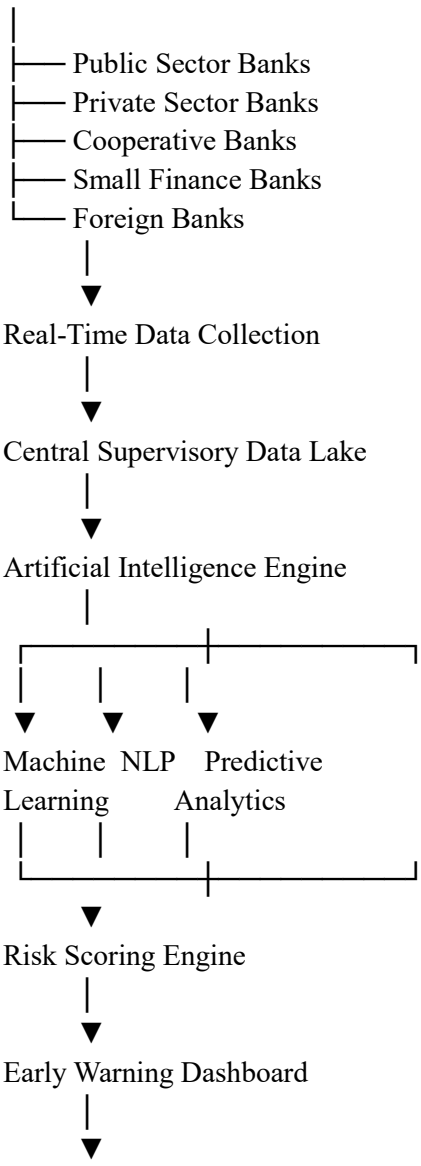
security logs, anti-money laundering alerts, regulatory returns, financial statements, customer complaints, and fraud reports. The Reserve Bank of India (RBI), as the banking regulator, receives a vast amount of supervisory information from Scheduled Commercial Banks, Urban Cooperative Banks, Small Finance Banks, and other regulated entities.

Traditional supervisory methods primarily rely on periodic reporting, on-site inspections, and manual analysis. Although these mechanisms have served the banking system effectively, they are becoming increasingly inadequate in an environment characterized by real-time digital transactions, fintech innovations, artificial intelligence-driven financial services, and sophisticated cyber threats.

Artificial Intelligence (AI) offers the RBI an opportunity to transition from **reactive supervision** to **predictive, preventive, and continuous supervision**. AI systems can process millions of transactions within seconds, identify hidden patterns, detect emerging risks, and generate early warning signals before financial stress becomes visible through conventional supervisory methods.

XVI. AI-BASED SUPERVISORY ARCHITECTURE FOR THE RESERVE BANK OF INDIA

The proposed AI-based supervisory framework consists of seven integrated layers.



This architecture enables continuous supervision instead of quarterly or annual reviews.

XVII. AI FOR MONITORING NON-PERFORMING ASSETS (NPAs)

17.1 Present Supervisory Challenges

Banks generally classify loans as Non-Performing Assets after repayment defaults exceed 90 days. Consequently, regulatory intervention often occurs after financial deterioration has already begun.

This approach has several limitations:

- Delayed identification of stress.
- Hidden loan restructuring.
- Evergreening of loans.
- Inadequate early warning indicators.
- Limited predictive capability.

AI can substantially overcome these limitations.

17.2 AI-Based Early Warning System (EWS)

The proposed AI model continuously analyses multiple borrower-specific variables.

17.2.1 Financial Variables

- Sales turnover
- Profitability
- EBITDA
- Cash flow
- Working capital
- Debt-equity ratio

17.2.2 Banking Variables

- Account turnover
- EMI repayment
- Loan utilization
- Overdraft frequency
- Cheque returns

17.2.3 External Variables

- GST returns
- Income Tax filings
- MCA filings
- Export-import performance
- Credit bureau data
- Commodity prices

17.2.4 Behavioural Variables

- Sudden cash withdrawals
- Frequent restructuring requests
- Connected-party transactions
- Multiple bank borrowing

The AI engine continuously computes a **Borrower Risk Score**.

Example:

Risk Score	Supervisory Action
0–20	Normal Monitoring
21–40	Increased Monitoring
41–60	RBI Alert
61–80	Supervisory Inspection
81–100	Immediate Intervention

17.3 Predictive Default Modelling

Machine learning algorithms can estimate the probability of default several months before an actual default occurs.

Common algorithms include:

- Random Forest
- XGBoost
- Logistic Regression
- Neural Networks
- Gradient Boosting
- Support Vector Machines

Instead of waiting for an account to become an NPA, RBI could identify borrowers likely to default six to twelve months in advance.

XVIII. AI FOR MONITORING PROFITABILITY

Profitability reflects the financial health and operational efficiency of banks. AI can continuously analyse profitability trends using:

- Net Interest Margin (NIM)
- Return on Assets (ROA)
- Return on Equity (ROE)
- Cost-to-Income Ratio
- Treasury Income
- Provision Coverage Ratio
- Fee Income
- Operating Expenses

AI Dashboard Example

Bank ABC

Profit Trend ↑

Operating Cost ↓

NPA Trend ↓

Credit Growth ↑

Cyber Risk Moderate

AI Risk Score 28/100

The RBI can compare profitability across peer groups and identify abnormal deviations requiring supervisory attention.

XIX. AI FOR CYBER SECURITY SUPERVISION

Cyber security has become one of the most significant supervisory concerns.
Banks face threats such as:

- Ransomware
- Phishing
- Malware
- Identity theft
- Insider attacks
- AI-generated fraud
- Deepfake voice attacks
- Data breaches

Traditional security systems often detect attacks after they occur.
AI can identify suspicious activity in real time.

19.1 Behavioural Analytics

Instead of relying solely on passwords, AI can evaluate:

- Typing speed
- Mouse movements
- Mobile touch patterns
- Login timings
- Geographic location
- Device fingerprint

Unusual behaviour automatically generates alerts.

19.2 Network Traffic Analysis

AI continuously monitors:

- Data packets
- Network latency
- File transfers
- Login attempts
- Privileged account access

Abnormal activity is isolated before significant damage occurs.

19.3 Fraud Detection

Machine learning models identify:

- Duplicate transactions
- Card cloning
- UPI fraud
- ATM fraud
- Fake KYC
- Money mule accounts
- Synthetic identities

XX. AI FOR ANTI-MONEY LAUNDERING (AML)

Money laundering often involves multiple accounts and complex transaction chains.
Traditional rule-based monitoring generates numerous false alerts.

AI improves AML through:

- Graph analytics
- Network analysis
- Pattern recognition
- Customer behavioural analysis
- Transaction clustering

The AI system can detect:

- Layering
- Round-tripping
- Circular transactions
- Shell companies
- Terror financing indicators

XXI. AI FOR GOVERNANCE SUPERVISION

Corporate governance failures have contributed to several banking crises.
AI can monitor:

- Board attendance
- Related-party lending
- Large connected exposures
- Management overrides
- Internal audit findings
- Regulatory breaches
- Employee misconduct

Natural Language Processing (NLP) can analyse:

- Audit reports
- Inspection reports
- Board minutes
- Statutory auditor observations
- Media reports

The system identifies governance concerns before they become systemic.

XXII. AI FOR SUPERVISING CO-OPERATIVE BANKS

Urban Cooperative Banks present unique supervisory challenges.

Common issues include:

- Limited technology infrastructure
- Weak governance
- Connected lending
- Political influence
- Higher fraud incidence
- Inadequate risk management

AI can provide enhanced supervision by:

- Monitoring branch-level cash movements.
- Identifying unusually rapid deposit growth.
- Detecting excessive concentration in a single sector.
- Flagging repeated restructuring of the same borrowers.

- Tracking insider lending.
- Identifying suspicious cash withdrawals.

This would enable RBI to intervene before financial instability develops.

XIII. AI-BASED STRESS TESTING

Traditional stress testing evaluates a limited number of economic scenarios.
AI can simultaneously simulate thousands of scenarios.
Examples include:

- GDP slowdown
- Inflation shock
- Interest rate increases
- Oil price spikes
- Exchange rate volatility
- Climate events
- Cyber attacks
- Pandemic-like disruptions

The AI system estimates:

- Capital adequacy.
- Liquidity coverage.
- Profitability.
- Credit losses.
- Provision requirements.

XXIV. AI-DRIVEN SUPERVISORY DASHBOARD

A centralized AI dashboard could display the following indicators for each regulated bank.

Indicator	AI Monitoring
Gross NPA	Daily
Net NPA	Daily
Capital Adequacy	Weekly
Liquidity	Real Time
Profitability	Monthly
Fraud Alerts	Real Time
Cyber Incidents	Real Time
Customer Complaints	Daily
Governance Risk	Continuous
Compliance Status	Continuous

The dashboard would assign every bank a **Composite Supervisory Risk Index (CSRI)** ranging from 0 to 100.
Example:

Score	Supervisory Category
0–20	Very Low Risk
21–40	Low Risk
41–60	Moderate Risk
61–80	High Risk
81–100	Critical Risk

Banks classified as High or Critical Risk would automatically trigger enhanced supervisory reviews and targeted inspections.

XV. CASE STUDIES DEMONSTRATING THE NEED FOR AI ENABLED SUPERVISION

25.1 Punjab and Maharashtra Cooperative (PMC) Bank

PMC Bank experienced severe financial distress due to concealed exposures, weak governance, and delayed detection of irregularities. An AI-driven supervisory system capable of analyzing connected lending, concentration risk, and anomalous reporting patterns could have generated early warning alerts, potentially enabling earlier regulatory intervention.

25.2 Yes Bank

Yes Bank faced significant asset quality deterioration, governance issues, and high corporate credit concentration. Predictive AI models using borrower cash-flow data, sectoral stress indicators, and concentration analytics might have identified emerging risks earlier, allowing supervisory measures before the bank's condition became critical.

25.3 Lakshmi Vilas Bank

Lakshmi Vilas Bank experienced prolonged financial weakness, declining profitability, governance concerns, and asset quality issues. Continuous AI-based monitoring of capital adequacy, liquidity, and governance indicators could have strengthened supervisory oversight during the deterioration phase.

25.4 Public Sector Banks

Many Public Sector Banks experienced elevated NPAs during the previous decade because of stressed corporate lending. Subsequent reforms—including stronger provisioning, Insolvency and Bankruptcy Code (IBC) recoveries, and improved credit monitoring—led to a substantial reduction in NPAs and record profitability. AI can reinforce these gains by enabling predictive credit surveillance, identifying emerging sectoral risks, and supporting more proactive supervision.

XVI. PROPOSED AI IMPLEMENTATIN ROADMAP FOR RBI

A phased implementation strategy is recommended:

Phase	Duration	Key Activities
Phase I	0–12 months	Create a centralized supervisory data lake; standardize regulatory reporting; initiate AI pilot projects using historical supervisory data.
Phase II	12–24 months	Deploy AI-based Early Warning Systems (EWS), fraud analytics, and cyber risk monitoring for Scheduled Commercial Banks.
Phase III	24–36 months	Expand AI supervision to Urban Cooperative Banks, NBFCs, and digital lenders; integrate external datasets (e.g., GST, MCA, credit information, where legally permissible).
Phase IV	36 months onward	Implement fully integrated, explainable AI-enabled continuous supervision with human oversight, governance controls, and periodic model validation.

XVII. COMPARATIVE STATISTICAL ANALYSIS OF BANKING SECTOR PERFORMANCE (FY 2020 – FY 2025)

27.1 The Indian banking sector has undergone a significant transformation during the five-year period from FY2020 to FY2025. The period began with challenges arising from accumulated stressed assets, the economic slowdown, and the impact of the COVID-19 pandemic. However, through regulatory reforms, improved risk management, enhanced provisioning, recovery mechanisms under the Insolvency and Bankruptcy Code (IBC), and stronger supervisory measures by the Reserve Bank of India, the banking sector achieved substantial improvement.

The major indicators considered for analysis are:

- Gross Non-Performing Assets (GNPA)
- Net Non-Performing Assets (NNPA)
- Profitability
- Capital Adequacy Ratio (CRAR)
- Credit Growth
- Cyber Security Risks
- Digital Banking Expansion

XVIII. TREND ANALYSIS OF NON-PERFORMING ASSETS (NPAs)

28.1 Gross NPA Ratio of Scheduled Commercial Banks

Financial Year	Gross NPA Ratio (%)
FY2020	8.2
FY2021	7.3
FY2022	5.9
FY2023	3.9
FY2024	2.7
FY2025	Approximately 2.3–2.5

28.2Analysis

The GNPA ratio declined significantly during the study period.
The major reasons include:

1. Improved credit appraisal systems.
2. Reduction in legacy corporate NPAs.
3. Recovery through IBC proceedings.
4. Higher provisioning coverage.
5. Strengthened RBI supervision.
6. Better risk management practices.

The reduction in NPAs demonstrates that regulatory reforms have produced positive outcomes. However, future challenges may arise from:

- Retail loan expansion.
- Unsecured lending growth.
- Digital lending risks.
- MSME stress.
- Interest rate fluctuations.

AI-based predictive models can help identify these risks before they convert into NPAs.

XXIX. COMPARATIVE NPA POSITION OF PUBLIC SECTOR BANKS, PRIVATE SECTOR BANKS AND CO-OPERATIVE BANKS

29.1 Category-wise GNPA Trends

Year	Public Sector Banks	Private Sector Banks	Cooperative Banks
FY2020	10.0%	5.5%	10%+
FY2021	9.1%	4.8%	9%+
FY2022	7.3%	3.8%	8%+
FY2023	5.5%	2.3%	6–7%
FY2024	4.0%	1.8%	5–6%
FY2025	Around 3%	Around 1.5%	Moderate improvement

29.2 Interpretation

29.2.1 Public Sector Banks

Public Sector Banks historically carried a higher share of stressed corporate loans. However, they demonstrated the largest improvement due to:

- Government recapitalization.
- IBC recoveries.
- Improved monitoring.
- Better provisioning.
- Strengthened governance.

The challenge ahead is maintaining asset quality while expanding credit rapidly.

29.2.2 Private Sector Banks

Private Sector Banks maintained comparatively lower NPAs because of:

- Stronger credit assessment.
- Technology-based lending.
- Better risk analytics.
-
- Diversified loan portfolios.

However, increased retail lending requires careful monitoring.

29.2.3 Cooperative Banks

Cooperative Banks remain relatively vulnerable because of:

- Limited risk management systems.
- Weak governance structures.
- Technology limitations.
- Higher concentration risks.

This segment requires greater use of AI-enabled supervisory mechanisms.

XXX. ANALYSIS OF BANKING SECTOR PROFITABILITY

30.1 Profitability Trend of Scheduled Commercial Banks

Financial Year	Profitability Trend
FY2020	Moderate profitability
FY2021	Recovery phase
FY2022	Strong improvement
FY2023	Significant growth
FY2024	Record profitability
FY2025	Continued strong earnings

XXXI. REASONS FOR IMPROVED PROFITABILITY

31.1 Reduction in Loan Loss Provisions

As NPAs declined, banks required lower provisioning, improving net profits.

31.2. Higher Credit Growth

Growth in:

- Retail loans
- MSME lending
- Housing finance
- Digital lending

supported income generation.

31.3. Improved Net Interest Margins

Higher lending rates and improved asset quality contributed to better margins.

31.4. Operational Efficiency

Digital banking reduced:

- Transaction costs.
- Branch operating costs.
- Processing time.

XXXII. CAPITAL ADEQUACY ANALYSIS

32.1 Capital Adequacy Ratio of Scheduled Commercial Banks

Financial Year	CRAR (%)
FY2020	14.7
FY2021	16.0
FY2022	16.8
FY2023	17.2
FY2024	17.7
FY2025	Above 17.5

32.2 Interpretation

The improvement in capital adequacy indicates:

- Stronger financial resilience.
- Greater ability to absorb losses.

- Lower probability of systemic failure.
- Better compliance with Basel III norms.

AI can assist RBI by predicting capital requirements under various stress scenarios.

XXXIII. CYBER SECURITY ANALYSIS OF INDIAN BANKS

33.1 Emerging Cyber Risks

Digital transformation has increased exposure to:

- Phishing attacks.
- Malware.
- Ransomware.
- Data theft.
- Identity fraud.
- Account takeover.
- Deepfake-based financial fraud.

The increase in digital transactions requires continuous monitoring rather than periodic cyber assessments.

33.2 AI-Based Cyber Security Solutions

AI can support RBI supervision through:

33.2.1 Real-Time Threat Detection

AI systems can identify:

- Abnormal login patterns.
- Suspicious transactions.
- Unauthorized access.

33.2.2 Predictive Cyber Analytics

AI can forecast:

- Vulnerable systems.
- High-risk branches.
- Potential attack points.

33.2.3 Automated Incident Response

AI can:

- Block suspicious activity.
- Isolate infected systems.
- Generate regulatory alerts.

XXXIV. CAUSES OF NPAs IN INDIAN BANKING SECTOR

34.1 Economic Slowdown

Economic downturns reduce borrower repayment capacity.

Major affected sectors include:

- Infrastructure.
- Steel.
- Power.
- Construction.
- Real estate.

34.2 Poor Credit Appraisal

Earlier lending practices suffered from:

- Inadequate due diligence.
- Overestimation of project viability.
- Weak monitoring.

34.3 Project Delays

Infrastructure projects experienced:

- Land acquisition problems.
- Regulatory delays.
- Cost overruns.

34.4 Diversion of Funds

Some borrowers diverted borrowed funds for:

- Unrelated businesses.
- Speculative activities.
- Personal purposes.

AI-based transaction analysis can detect such patterns.

34.5 Governance Issues

Weak governance resulted in:

- Poor lending decisions.
- Connected lending.
- Inadequate monitoring.

34.6 External Factors

Factors affecting repayment include:

- Inflation.
- Interest rate increases.
- Global economic uncertainty.
- Commodity price fluctuations.
- Pandemic disruptions.

XXXV. MAJOR FINDINGS OF THE STUDY

Based on the analysis, the following findings emerge:

35.1 The Indian banking sector has achieved substantial improvement in asset quality, with GNPA ratios declining significantly between FY2020 and FY2025.

35.2 Public Sector Banks have shown the greatest improvement in financial performance due to regulatory reforms and better risk management.

35.3 Private Sector Banks continue to maintain superior operational efficiency and technology adoption.

35.4

Cooperative Banks remain the most vulnerable category due to governance weaknesses and technology limitations.

35.5

Traditional supervisory methods alone are insufficient for monitoring modern digital banking risks.

35.6

Artificial Intelligence can significantly improve RBI's ability to:

- Predict NPAs.
- Detect fraud.
- Monitor cyber threats.
- Assess governance risks.
- Conduct continuous supervision.

35.7

AI adoption requires strong governance, explainability, data quality standards, and human oversight.

XXXVI. SUGGESTIONS AND RECOMMENDATIONS

36.1 Establish an RBI Artificial Intelligence Supervision Centre

The RBI should create a dedicated AI-based supervisory division consisting of:

- Data scientists.
- Banking experts.
- Cyber security specialists.
- Risk professionals.
- AI governance experts.

36.2 Develop a Unified Banking Supervisory Data Lake

A centralized data platform should integrate:

- Regulatory returns.
- Loan information.
- Transaction data.
- Fraud reports.
- Cyber incidents.
- Market information.

This will enable comprehensive risk assessment.

36.3 Implement AI-Based NPA Prediction Models

Banks should submit AI-generated risk indicators for major borrowers.

The RBI should monitor:

- High-value exposures.
- Sectoral concentration.
- Borrower risk scores.

36.4 Strengthen Cooperative Bank Supervision Through AI

Special AI tools should be developed for cooperative banks to monitor:

- Governance risks.
- Fraud indicators.
- Deposit concentration.
- Connected lending.

36.5 Establish AI-Based Cyber Security Monitoring

A central cyber intelligence platform should analyse:

- Threat patterns.
- Malware incidents.
- Fraud networks.
- Digital transaction abnormalities.

36.6 Introduce Explainable Artificial Intelligence (XAI)

AI decisions affecting supervision must be:

- Transparent.
- Auditable.
- Explainable.

Human supervisors should retain final decision-making authority.

36.7 Develop AI Governance Guidelines

RBI should issue guidelines covering:

- Model validation.
- Data quality.
- Algorithmic bias.
- Cyber protection.
- Accountability.

36.8 Continuous Training of Supervisory Personnel

RBI officers should receive training in:

- Machine learning.
- Data analytics.
- Cyber security.
- AI governance.

XXXVII. LIMITATIONS OF THE RESEARCH

The study has certain limitations:

1. The research is based primarily on secondary data.
2. AI adoption in Indian banking supervision is still developing.
3. Availability of detailed cyber security data is limited due to confidentiality.
4. Exact AI implementation costs could not be evaluated.
5. Future technological developments may change supervisory requirements.

XXXVIII. SCOPE FOR FUTURE RESEARCH

Future research may focus on:

1. Development of AI-based NPA prediction models using actual banking data.
2. Comparative studies between RBI and international regulators using AI.
3. AI applications in cooperative bank supervision.
4. Impact of Generative AI on banking fraud.
5. AI governance frameworks for financial regulators.
6. Use of blockchain and AI integration in banking supervision.
7. Measuring cost-benefit analysis of AI implementation by RBI.

XXXIX. CONCLUSION

The Indian banking sector has undergone a remarkable transformation during FY2020–FY2025, reflecting the success of reforms implemented by the Reserve Bank of India (RBI) and the Government of India. The significant reduction in Non-Performing Assets (NPAs), improved profitability, stronger capital adequacy, and enhanced regulatory and supervisory frameworks have contributed to a more stable, resilient, and efficient banking system. These achievements have strengthened public confidence and reinforced the sector's ability to support India's economic growth.

Despite these improvements, the banking environment is becoming increasingly complex due to rapid digitalization, the expansion of fintech, evolving cyber threats, sophisticated financial frauds, and the growing interconnectedness of financial systems. Conventional supervisory approaches, while effective in the past, are no longer sufficient to address the dynamic risks of a digital financial ecosystem. This changing landscape requires supervisory mechanisms that are proactive, predictive, and capable of continuous monitoring rather than relying solely on periodic inspections.

Artificial Intelligence (AI) presents a significant opportunity to transform banking supervision in India by enabling a next-generation regulatory framework based on predictive analytics, real-time monitoring, intelligent risk assessment, and automated early warning systems. AI can assist the RBI in identifying stressed assets before default, monitoring bank profitability, detecting fraud, strengthening cybersecurity, improving governance oversight, enhancing supervision of cooperative banks, and promoting overall financial stability. By leveraging large volumes of financial data, AI can support faster and more informed regulatory decision-making while improving supervisory efficiency and accuracy.

The comparative analysis of the RBI and global central banks demonstrates that AI-driven supervision has the potential to substantially enhance regulatory effectiveness through improved risk identification, better asset quality management, stronger cybersecurity surveillance, and continuous financial stability monitoring. However, successful implementation depends on robust data governance, advanced technological infrastructure, skilled human resources, ethical AI practices, and transparent regulatory frameworks that ensure accountability, fairness, and explainability in AI-based decision-making.

The proposed Artificial Intelligence-Based Supervisory Framework provides a future-oriented model for the RBI by integrating predictive analytics, real-time supervisory dashboards, cybersecurity intelligence, adaptive

regulatory mechanisms, and human expertise into the supervisory process. Such a framework can enable Indian banking supervision to become more resilient, efficient, and responsive to emerging financial risks while maintaining transparency and regulatory integrity.

In conclusion, the future of banking supervision lies not only in ensuring regulatory compliance but also in adopting intelligent, data-driven, and technology-enabled oversight. By responsibly integrating Artificial Intelligence into its supervisory architecture, the Reserve Bank of India can strengthen the resilience of the banking sector, enhance financial stability, and position India as a global leader in modern, technology-driven financial regulation in the digital era.

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