

Hybrid Explainable AI and Blockchain Frameworks for Secure Financial Decision Making

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Abstract:

The rapid digital transformation of the financial sector has increased the use of Artificial Intelligence (AI), Machine Learning (ML), blockchain and advanced analytics for credit assessment, fraud detection, investment analysis, risk management and customer decision-making. Although AI can process large volumes of financial data and generate highly accurate predictions, the increasing complexity of AI models creates concerns regarding transparency, accountability, data integrity and trust. Blockchain, with its decentralised and tamper-evident architecture, can provide an additional layer of data provenance, auditability and integrity, while Explainable Artificial Intelligence (XAI) can make algorithmic decisions more understandable to financial institutions, customers and regulators. This study develops a conceptual hybrid framework integrating AI, XAI and blockchain for secure financial decision-making. The proposed framework combines secure data acquisition, blockchain-based provenance, AI prediction, XAI explanation, smart-contract-based governance and human oversight. The paper argues that the combination of these technologies can strengthen transparency, traceability, security and responsible financial decision-making, although scalability, privacy, interoperability, model risk and regulatory governance remain significant challenges.

Keywords: Artificial Intelligence, Explainable AI, Blockchain, Financial Decision Making, FinTech, Credit Scoring, Indian Banking.

Introduction

The financial-services industry is undergoing a significant technological transformation. Banking institutions increasingly rely on digital payments, cloud computing, artificial intelligence, machine learning, blockchain, mobile applications and automated decision systems. These technologies have improved transaction speed, customer experience, risk analysis and operational efficiency, but they have also increased dependence on reliable data and trustworthy digital infrastructure.

Artificial Intelligence has become particularly important in financial decision-making. AI and ML models are increasingly used for credit scoring, fraud detection, customer segmentation, risk assessment, investment analysis and regulatory compliance. A 2024 NVIDIA survey reported that 91% of financial-

services companies were either assessing AI or already using AI in production, indicating the rapid movement of AI from experimentation toward operational deployment.

The growth of AI creates an important challenge: financial decisions need to be not only accurate but also explainable and auditable. A highly accurate credit model may determine that a customer is unsuitable for a loan, but the customer and the financial institution may need to understand why that decision was made. Explainable AI addresses this issue by providing information about the factors contributing to a prediction.

At the same time, financial decision-making requires trustworthy data. Blockchain can contribute by maintaining a tamper-evident record of data transactions, model versions, approvals and decision-related events. The combination of blockchain and AI therefore offers a promising architecture in which AI provides intelligence, XAI provides interpretability and blockchain provides traceability and integrity.

Background of the Study

Artificial Intelligence in Financial Services:

AI can analyse large datasets and identify relationships that may not be easily detected through traditional statistical methods. Financial institutions use AI for: Credit-risk assessment, Fraud detection, Anti-money-laundering monitoring, Investment analysis, Customer segmentation, Financial forecasting, Risk management

Automated customer service.

Explainable Artificial Intelligence

Traditional AI models can sometimes operate as "black boxes." Their predictions may be accurate but difficult to interpret.

Common XAI methods include SHAP, LIME, Feature importance, Decision rules

Counterfactual explanations, Partial-dependence analysis

Blockchain in Financial Decision-Making

Blockchain is a distributed ledger technology that records transactions across a network using cryptographic mechanisms and consensus procedures.

In financial applications, blockchain can potentially support Data integrity, Transaction traceability, Audit trails, Identity management, Smart contracts, Multi-party data sharing, Model-governance records. A major advantage of blockchain is that changes to recorded information can be detected, creating stronger data-provenance mechanisms.

However, blockchain does not automatically make every financial system secure. Poor smart-contract design, compromised endpoints, privacy leakage, scalability limitations and interoperability problems can still create risks.

Therefore, blockchain should be viewed as a trust and governance layer, rather than a complete replacement for cybersecurity.

Need for a Hybrid AI–XAI–Blockchain Framework

AI, XAI and blockchain address different weaknesses.

Technology

Artificial Intelligence

Explainable AI

Blockchain

Smart Contracts

Human Oversight

Primary contribution

Prediction and pattern recognition

Interpretation and transparency

Data integrity and auditability

Automated governance

Accountability and judgement

A hybrid architecture can therefore be represented as:

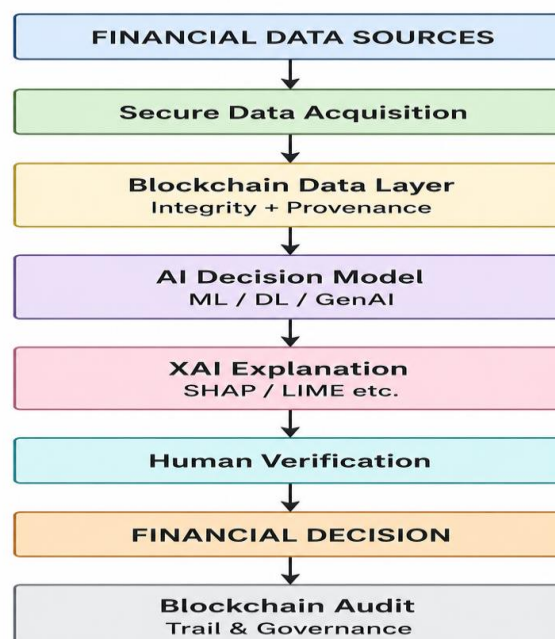
- AI = Intelligence
- XAI = Explanation
- Blockchain = Trust
- Human Oversight = Accountability

The combination can provide a stronger foundation for high-impact financial decisions.

Research Objectives

- To examine the role of AI in modern financial decision-making.
- To analyse the importance of Explainable AI for transparent financial decisions.
- To examine the role of blockchain in financial data integrity and auditability.
- To develop a conceptual AI–XAI–blockchain framework for secure financial decision-making.
- To examine the benefits and limitations of integrating these technologies.
- To discuss the relevance of the framework to Indian banking and digital financial services.

Overall Hybrid Framework

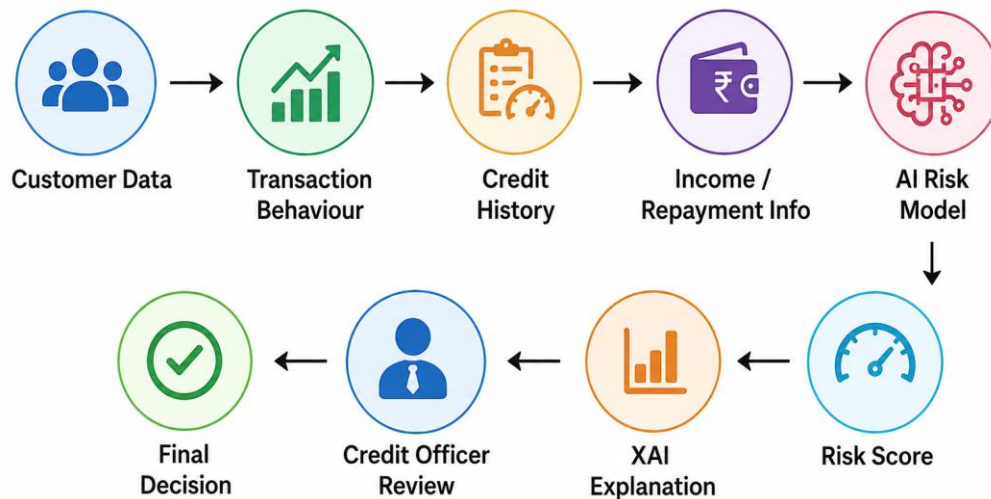


AI-Based Financial Decision Process

The AI component can analyse multiple financial indicators simultaneously.

For example, in credit scoring:

This process is preferable to completely automated decision-making because financial decisions can have significant consequences for customers.



Indian Banking Perspective

India provides an important environment for examining the proposed framework because of its rapid digital-payment growth and increasing adoption of emerging technologies.

The RBI reported that digital retail transactions represented 90.9% of total retail-payment value in 2023–24, while UPI accounted for 79.6% of retail-payment transaction volume.

The RBI has also created an EmTech Repository to collect information regarding financial institutions' adoption of emerging technologies, including AI, machine learning, cloud computing and distributed ledger technology.

The RBI has identified cybersecurity, data privacy and third-party/vendor risk as important challenges arising from financial-sector digitalisation.

These developments make a hybrid AI-XAI-blockchain architecture particularly relevant to Indian financial institutions.

Potential applications include:

- AI-based credit assessment.
- Fraud detection.
- Digital-payment risk monitoring.
- AML transaction monitoring.
- Insurance underwriting.
- Investment-risk analysis.
- Supply-chain finance.
- Financial inclusion.

- Digital identity verification.
- Regulatory reporting.

Benefits of the Proposed Framework

Improved Transparency- XAI can provide understandable explanations for financial predictions.

Stronger Data Integrity- Blockchain provides a tamper-evident record of selected transactions and governance events.

Improved Accountability- Decision records can be maintained for internal and regulatory audits.

Privacy-Preserving Collaboration- Federated learning can enable institutions to collaborate without necessarily pooling raw customer data.

Better Fraud Detection- AI can identify complex patterns and anomalies across large transaction datasets.

Improved Customer Trust- Customers may have greater confidence when financial decisions can be explained and audited.

Regulatory Support- A transparent decision trail can support model governance, compliance and supervisory review.

Risk-Mitigation Matrix

Risk	Potential impact	Recommended control
AI bias	Unfair financial decisions	Bias testing and human review
Model drift	Reduced prediction accuracy	Continuous model monitoring
Data tampering	Incorrect decisions	Blockchain provenance
Privacy leakage	Customer harm	Encryption and access controls
Black-box decisions	Low trust	XAI
Smart-contract errors	Automated failures	Formal testing and audit
Cyberattack	Financial disruption	Multi-layer cybersecurity
Regulatory non-compliance	Legal/reputational risk	Governance and audit framework
Poor data quality	Incorrect predictions	Data validation
Blockchain scalability	Transaction delays	Permissioned/hybrid architecture

The evidence indicates that AI adoption in financial services is no longer limited to experimental applications. The 91% AI adoption/assessment figure reported by NVIDIA illustrates the industry's movement toward operational AI. At the same time, the systematic review by Černevičienė and Kabašinskas demonstrates that explainability has become a significant research area in finance, with 138 relevant studies identified and credit management representing 44% of the reviewed applications.

The integration of blockchain introduces a complementary capability. AI can produce predictions, but blockchain can help document data provenance and decision-related events. XAI can explain the prediction, while human experts retain responsibility for consequential decisions.

Therefore, the proposed architecture can be understood as a three-dimensional trust model:

Intelligence

AI → Prediction

Transparency

XAI → Explanation

Integrity

Blockchain → Verification

Together:

AI + XAI + Blockchain = Intelligent + Explainable + Auditable Financial Decision-Making

However, the integration should be selective rather than technologically excessive. Blockchain should be used where immutable provenance and multi-party trust provide meaningful value; sensitive raw data need not automatically be placed on-chain.

The BIS also highlights that AI in finance can improve areas such as KYC, AML, anomaly detection, fraud detection and risk analysis, while simultaneously creating concerns relating to model risk, privacy, governance and accountability.

Conclusion

The integration of Artificial Intelligence, Explainable AI and blockchain presents a promising approach to improving the security, transparency and reliability of financial decision-making. AI provides predictive intelligence, XAI addresses the interpretability problem and blockchain can strengthen data provenance and auditability.

The statistical evidence demonstrates the growing importance of these technologies. Financial-services organisations are rapidly adopting AI, while India's digital-payment ecosystem has reached substantial scale. In parallel, academic research increasingly recognises explainability as essential for trustworthy financial AI.

The proposed hybrid framework provides a conceptual architecture in which AI performs prediction, XAI explains decisions, blockchain records trusted evidence and human experts retain accountability. This approach is particularly relevant for credit scoring, fraud detection, AML, digital payments, insurance and investment decision-making.

For India, the framework is particularly relevant because rapid digital-payment growth and increasing adoption of emerging technologies are creating increasingly complex financial ecosystems. The future of secure financial decision-making is therefore unlikely to be based on a single technology. Instead, it will depend on the responsible convergence of AI, explainability, distributed trust, cybersecurity and human governance.

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