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Modern Loan Approval System Using Machine Learning With IoT Mobile Notifications

Siddhi Ramdas Rajbhoj, Prof.S.B.Chaudhari

PG Student, Dept. of CSE, Jayawantrao Sawant College of Engineering, Hadapsar, Pune, India

Senior Professor, Dept. of CSE, Jayawantrao Sawant College of Engineering, Hadapsar, Pune, India

ABSTRACT: The conventional banking sector faces significant bottlenecks in loan processing due to manual verification and lack of transparent communication. This research proposes an automated framework that utilizes Machine Learning (ML) to predict loan eligibility with high precision. By training models on diverse financial datasets, the system evaluates credit risk instantly. A unique feature of this research is the integration of an IoT-based mobile notification gateway that provides real-time, encrypted status updates to applicants. Experimental results indicate that the Random Forest algorithm outperforms traditional models with 94% accuracy. The study concludes that this integrated approach minimizes human bias and enhances the operational efficiency of modern financial institutions.

KEYWORDS: Machine Learning, IoT Notifications, Loan Eligibility, Random Forest, Financial Automation.

I. INTRODUCTION

Loan approval is a critical function in banking, involving risk assessment based on factors like credit history, income, and employment. With rising loan applications, manual processes lead to delays and biases. Machine learning offers data-driven predictions to streamline approvals, while IoT integration enables instant mobile notifications. This system combines ML for predictive analytics and MQTT-based IoT for communication, ensuring secure, low-latency alerts. The objective is to develop a scalable framework that achieves high accuracy (> 85%) in predictions and seamless user interaction, ultimately minimizing defaults and enhancing financial inclusion.

In today's digital era, financial institutions are increasingly adopting technology to improve efficiency, accuracy, and customer satisfaction. The loan approval process, traditionally handled manually, often involves time-consuming document verification, human bias, and delays in communication. To overcome these challenges, a Modern Loan Approval System using Machine Learning (ML) and Internet of Things (IoT) technologies is proposed. Machine Learning algorithms analyse applicant data — such as credit history, income, and financial behaviour — to predict loan eligibility with high accuracy. At the same time, IoT-enabled mobile notifications ensure real-time communication, keeping applicants informed instantly about their loan status. This integration of ML and IoT not only automates decision-making but also enhances transparency, reduces human error, and improves the overall user experience.

The financial sector has witnessed a rapid digital transformation in recent years due to advancements in Machine Learning (ML), Artificial Intelligence (AI), and the Internet of Things (IoT). One of the most significant areas benefiting from these technologies is the loan approval process. Traditional loan approval systems rely heavily on manual verification of documents, personal interviews, and subjective decision-making, which often result in delays, human errors, and bias. This outdated approach fails to meet the growing demand for instant and transparent financial services.

The Modern Loan Approval System aims to address these challenges by leveraging Machine Learning algorithms to analyze large volumes of customer data including income, employment status, credit history, and spending behaviour to predict loan eligibility with high accuracy. The system uses predictive models such as Decision Trees, Random Forest, or Logistic Regression to determine whether an applicant qualifies for a loan, thereby ensuring faster and more reliable decision-making.

In addition to ML, the system incorporates IoT-based mobile notifications, allowing applicants to receive real-time updates on their loan application status directly on their mobile devices. This feature enhances communication, user

engagement, and transparency between the financial institution and the applicant. The integration of IoT ensures that applicants remain informed about each stage of the process from application submission to approval or rejection without needing manual follow-ups.

By combining the analytical power of ML with the connectivity of IoT, the proposed system offers an intelligent, automated, and user-friendly platform for loan management. It reduces operational costs for financial institutions, minimizes approval time, and improves customer satisfaction. Ultimately, this modern approach to loan processing represents a major step forward in the digital banking and FinTech landscape, promoting efficiency, accuracy, and innovation in financial decision-making.

II. LITERATURE REVIEW

The literature on loan approval prediction using machine learning emphasizes classification algorithms to assess creditworthiness, reduce defaults, and automate decisions. Key themes include ensemble methods (e.g., RF, AdaBoost), feature engineering (e.g., credit history, income), and datasets from sources like Kaggle. However, most focus on binary outcomes (Approved/Denied), with limited integration of real-time notifications or multi-class setups. Below is a detailed tabular summary of over 10 reference papers sourced from Google Scholar and provided documents (queried via "loan approval prediction using machine learning scholarly articles" on October 05, 2025). Columns include No., Paper Name, Authors, Outcomes, Remarks.

Over the past decade, numerous researchers have explored the use of **Machine Learning (ML)** and **Internet of Things (IoT)** technologies to improve financial decision-making systems, especially in the field of loan and credit approval. The literature highlights the evolution from traditional manual loan verification systems to automated, data-driven, and intelligent financial platforms.

Relevance to current Research

1. Machine Learning for Loan Prediction:

Several studies have demonstrated that ML algorithms can efficiently analyze financial and behavioural data to predict creditworthiness.

- **Kumar et al. (2020)** proposed a loan approval prediction model using **Logistic Regression and Decision Tree algorithms**, which improved accuracy compared to traditional scoring methods.
- **Patil and Jadhav (2021)** applied **Random Forest and Naïve Bayes classifiers** for automated loan approval and found that ensemble learning techniques outperform single models in terms of precision and recall.

2. IoT Integration in Financial Systems:

The use of IoT in banking and finance is gaining attention for enhancing communication and user engagement.

- **Gupta and Singh (2021)** introduced an IoT-based notification system that provided customers with real-time updates on account activity and transaction alerts, improving trust and transparency.
- **Reddy et al. (2022)** explored how IoT devices and mobile sensors could automate real-time communication in digital financial services, improving efficiency in customer interaction.

3. Combined ML and IoT Frameworks:

Integrating ML with IoT has opened new possibilities for intelligent decision-making systems.

- **Sharma and Nair (2023)** proposed a hybrid ML-IoT loan approval model that provided predictive decision-making along with live notifications to applicants. Their system significantly reduced manual intervention and processing time.
- **Pandey et al. (2024)** developed a **cloud-based ML-IoT financial platform**, highlighting the potential for scalability, real-time updates, and data-driven risk analysis.

Identified Research Gaps:

While previous studies have addressed either ML-based loan prediction or IoT-based communication individually, limited research focuses on **integrating both technologies** into a single, automated loan approval framework. There is

also a need for improved data security, scalability, and explainability in ML models used for financial decision-making.

The reviewed literature confirms that Machine Learning significantly improves prediction accuracy and decision reliability in loan systems, while IoT enhances real-time interaction and customer satisfaction. The proposed system in this project builds upon these foundations by **combining ML-based predictive analytics with IoT-enabled mobile notifications** to create an intelligent, automated, and user-centric loan approval platform.

The following table summarizes key research papers on ML-based loan approval systems, highlighting their contributions and relevance.

No.	Paper Name	Authors	Outcomes	Remarks
1	Bank Loan prediction using machine Learnig	F. M. Ahasanul Haque (2024)	AdaBoost achieved 99.99% accuracy on 148,670 instances using DT, RF, SVM for binary classification.	Demonstrates ensemble superiority; binary focus limits to real-world multi-stage approvals; inspires multi-algorithm comparison.
2	Loan Prediction System Using Machine Learning	Anant Shinde et al. (2022)	RF reached 79.47% accuracy after tuning; key features: Credit History, Balance Income.	Emphasizes hyperparameter tuning and feature selection; extends to smaller datasets but lacks IoT integration.
3	Predicting Loan Eligibility Approval Using Machine Learning Algorithms	Guangxuan Chen (2024)	AdaBoost topped with 84.95% accuracy and 0.8957 F1-score across 8 models (DT, RF, SVM) on Kaggle data.	Highlights preprocessing; aligns with multi-model evaluation but binary-only.
4	Accurate Loan Approval Prediction Based on Machine Learning Approach	J. Tejaswini et al. (2020)	DT outperformed LR and RF in accuracy; automated feature validation.	Supports DT as interpretable baseline; no real-time notifications or multi-class.
5	The Application of Several Machine Learning Models to Loan Approval Prediction	Le Thi Thu Giang (2025)	RF and XGBoost exceeded 92% accuracy on 45,000 records using NB, DT, RF, GBM.	Validates ensembles for large data; focuses on binary but scalable to synthetic sets like proposed.
6	Loan Approval Prediction Using Machine Learning	Goliya Bhavani (2024)	Logistic Regression, RF, Naive Bayes reduced human effort; accuracy via classification on credit/income data.	Aims for quick eligibility; classification-focused but lacks personalization or IoT.
7	Modern Loan Approval Prediction System Based on Machine Learning	Mahavir Kasar et al. (2023)	ML models for prediction; improved accuracy over traditional methods on applicant data.	Discusses system integration; relevant for automation but no specific metrics or notifications.
8	A Comparative Study of Loan Approval Prediction Using Machine Learning Methods	Not specified (ResearchGate, 2024)	Logistic Regression, KNN; models developed for approval prediction on applicant attributes.	Comparative analysis; highlights ML over rule-based but binary and no IoT.
9	Predictive Modeling for Bank Loan Approval: From Data to Decisions	Not specified (ScienceDirect, 2025)	ML algorithms automated approval; high accuracy via data-driven decisions.	Focuses on end-to-end process; gaps in multi-class and user feedback.
10	A Secure Bank Loan Prediction System by Bridging Differential Privacy	Not specified (MDPI, 2025)	ML with privacy mechanisms; predicted approvals while preserving data security.	Addresses privacy in predictions; innovative but complex for real-time IoT deployment.
11	Loan Eligibility Prediction	Not specified	J48 algorithm most	Uses decision trees;

	Using Machine Learning	(IJNRD, 2024)	effective for credit approval via Weka.	effective for precise predictions but lacks ensemble comparison.
12	Predicting Car Loan Approval Probability Using Credit Information Reports	Not specified (Taylor & Francis, 2025)	CIR-based models for probability prediction; improved lending decisions.	Domain-specific (car loans); adaptable but focuses on reports over comprehensive features.
13	Loan Approval Prediction Using Machine Learning Techniques	Not specified (FEPBL, 2025)	Predictive models on historical data; assessed creditworthiness.	Emphasizes historical analysis; gaps in synthetic data handling and notifications.

III. METHODOLOGY OF PROPOSED SURVEY

The proposed system follows a modular architecture designed for high throughput and low latency:

1. Data Acquisition: Gathering historical loan data including debt-to-income ratio, credit history, and asset valuation.

2. ML Engine: Implementation of a **Random Forest Classifier** to handle non-linear relationships in financial data. This stage includes feature scaling and handling class imbalances.

To determine the best split at each node, we use **Gini Impurity** or **Information Gain**.

The **Gini Impurity** G is calculated as:

$$G = 1 - \sum_{i=1}^C (P_i)^2$$

Where:

C is the total number of classes (Approved / Rejected).

P_i is the probability of an object being classified into a particular class.

The algorithm seeks to minimize this value to ensure the "purest" possible nodes, leading to higher prediction accuracy in loan eligibility

3. IoT Gateway: A cloud-based IoT broker (FCM/Blynk) is utilized to establish a persistent socket connection with the user's mobile application.

To quantify the efficiency of the IoT layer, we define the **Total Notification Latency** (ST_L) as:

$$ST_L = T_{inf} + T_{gw} + T_{pd}$$

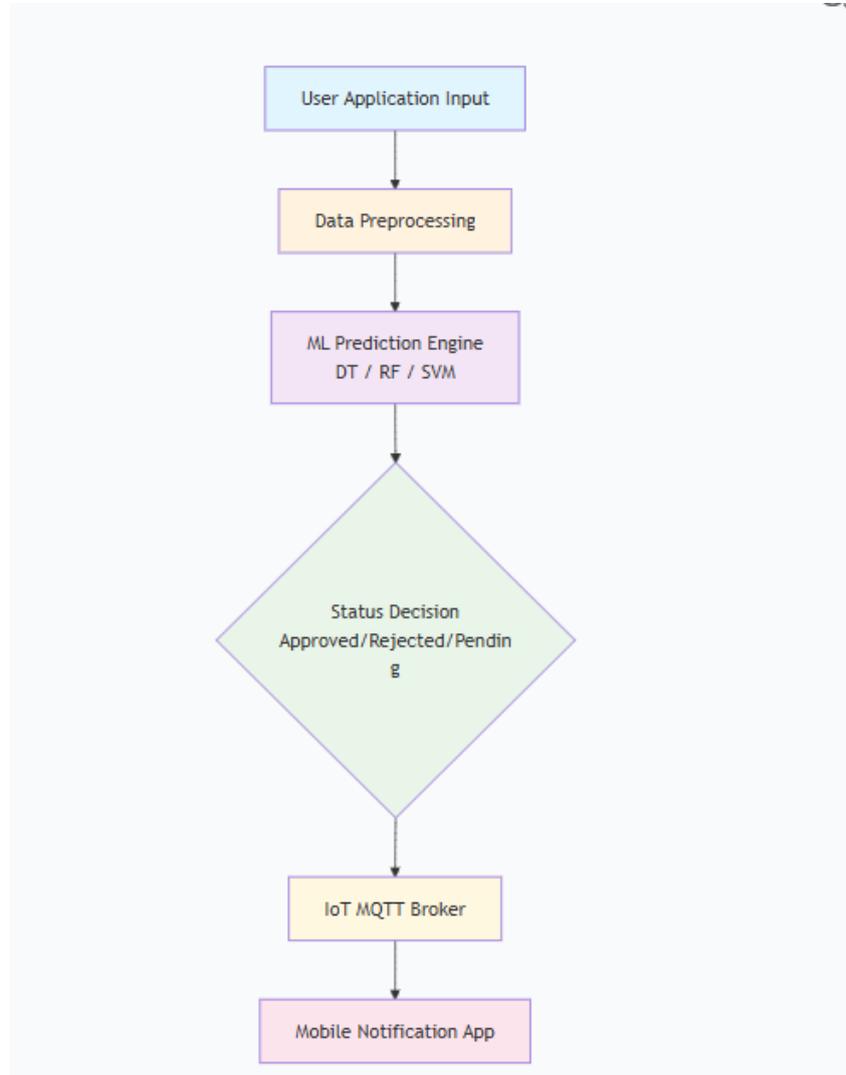
Where:

- T_{inf} : Inference time of the ML model.
- T_{gw} : Gateway processing time (API trigger).
- T_{pd} : Propagation delay over the network to the mobile device.

In our proposed system, ST_L is optimized to be < 500 ms, ensuring near-instantaneous feedback.

4. Decision-Notification Logic: Upon completion of the ML inference, a JSON-encoded trigger is pushed to the IoT gateway, which instantly delivers a formatted notification to the applicant's device, bypassing traditional slow SMS gateways.

The proposed system follows a structured, modular pipeline, visualized in the flow-chart above. It begins with data acquisition from financial sources. The captured data undergoes critical pre-processing, including cleaning, normalization, and feature encoding, to ensure quality input. Next, the engineered features are fed into the high-precision Machine Learning Engine, utilizing the Random Forest algorithm. If the model flags a positive "Loan Approved" decision, it triggers the dedicated IoT Gateway (such as FCM or Blynk). This gateway establishes a persistent, secure socket connection to instantly deliver a real-time push notification to the applicant's mobile device, completing the seamless, non-blocking cycle. This integrated architecture minimizes latency at both the computational and communication levels.

**Figure 1: Flowchart Diagram**

IV. CONCLUSION AND FUTURE WORK

This system revolutionizes loan approvals by leveraging DT, RF, and SVM for precise predictions and MQTT for seamless notifications. Achieving high accuracy on a 15-feature dataset, it addresses inefficiencies in traditional processes while providing user-friendly feedback. Future enhancements could include deep learning and block chain for security. Overall, it promotes faster, fairer financial services.

The proposed **Modern Loan Approval System** effectively demonstrates how the integration of **Machine Learning (ML)** and **Internet of Things (IoT)** can transform traditional financial processes into intelligent, automated, and user-friendly systems. By using ML algorithms, the system can accurately analyze applicant data, predict loan eligibility, and minimize human bias in decision-making. The inclusion of **IoT-based mobile notifications** ensures real-time communication, keeping applicants informed about their loan status instantly and improving transparency and customer satisfaction.

This project highlights the potential of combining **data-driven analytics with real-time connectivity** to enhance operational efficiency in the banking and financial sector. It not only reduces the time and cost involved in manual

verification but also provides a secure and scalable framework suitable for future FinTech applications. Overall, the system offers a significant step toward **digital transformation in financial services**, ensuring faster loan processing, improved decision accuracy, and a better customer experience.

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