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Intelligent and Secure Bank Management System: A Flask-Oracle Based Web Platform with Suspicious Login Detection and Smart Spending Analytics

Pratiksha Petkar[1], Tejas Shriram[2], Anushka Mundhe[3], Sudarshan J. Sikchi[4]

[1,2,3,4]Department of Computer Engineering, Cusrow Wadia Institute of Technology, Pune.

Abstract

The rapid growth of digital banking has improved the speed and efficiency of financial services. However, it has also created new challenges related to security and financial awareness. Most traditional Bank Management Systems mainly focus on basic operations such as account management, balance checking, fund transfer, and transaction history. These systems often do not address important real-world issues like detecting suspicious login activities and helping users understand their spending habits. This paper presents a complete and secure bank management system developed using Flask and Oracle Database. The system allows users to perform banking operations such as account creation, deposit, withdrawal, and fund transfer. It also includes security features such as password hashing and suspicious login detection. The suspicious login detection module analyzes login patterns using factors like IP address, device information, login time, and failed attempts to identify risky activity and improve system security. In addition, the system includes a smart spending analyzer that helps users understand their expenses. It categorizes transactions, displays spending patterns, and provides alerts to improve financial awareness. Along with these features, the system reduces manual work, improves accuracy, and provides better transparency. The proposed system is useful for educational purposes and small-scale banking applications, and it offers a practical solution to improve both security and user financial understanding.

Keywords - Bank Management System, Flask, Oracle Database, Security, Web Application, Spending Analysis

I. INTRODUCTION

Banking systems play a very important role in daily life. People depend on banks for saving money, transferring funds, and managing financial activities. Traditional banking systems are mostly manual and require a high level of human effort. These systems are often slow, less accurate, and difficult to manage when the volume of data increases. To overcome these limitations, modern banking systems use digital technology to provide fast, secure, and efficient services.

In recent years, the banking sector has experienced a major digital transformation. This transformation is

mainly driven by advancements in technology and the growing demand for better financial services. Manual banking processes are now replaced by computerized systems that improve speed, accuracy, and reliability. Modern banking systems use software applications to manage customer accounts, transactions, deposits, and other financial services. These systems also support better data storage, enhanced security, and real-time tracking of financial activities. As a result, banks are able to provide improved services and maintain their competitiveness in a rapidly changing environment.

The development of digital banking systems has significantly changed the way financial services are delivered. In earlier times, banking operations were carried out manually, which often led to delays, errors, and inefficiency. Managing records required extensive paperwork, and retrieving information was time-consuming.

With the introduction of computer-based systems, banks began to automate their operations. This shift improved efficiency and reduced the chances of human error. Modern banking systems now rely on databases and web applications to store and manage large volumes of customer data. These systems ensure that information is stored securely, organized properly, and can be accessed quickly when needed. Real-time processing allows users to perform transactions instantly, which improves overall user experience.

Digital systems also help in reducing paperwork and improving operational efficiency. This transformation is essential for banks to meet customer expectations and remain competitive in today's technology-driven world.

Even though digital banking has improved many processes, several limitations still exist in traditional bank management systems. Most systems mainly focus on basic functions such as account creation, balance checking, and transaction processing. They do not fully address advanced requirements related to system security and user financial awareness.

One of the major issues is the lack of proper detection of suspicious login activities, which increases the risk of unauthorized access and fraud. Many systems also do not provide tools for analyzing user spending behavior, which limits the ability of users to understand and manage their finances effectively. In addition, these systems often depend heavily on manual monitoring by administrators, which can be inefficient and time-consuming.

These challenges highlight the need for an improved banking system that not only performs core operations but also ensures better security and provides meaningful insights to users.

The main objective of this project is to develop a secure and efficient Bank Management System using modern web technologies. The system aims to automate essential banking operations such as account management, deposits, withdrawals, and fund transfers. It also focuses on improving security by implementing a suspicious login detection mechanism that can identify risky login behavior.

Another important objective is to provide a smart spending analyzer that helps users understand their financial habits by analyzing their transaction data. The system also aims to maintain data accuracy and integrity while providing a user-friendly interface for both users and administrators. Overall, the goal is to create a system that combines functionality, security, and usability in a single platform.

This study is important because it focuses on improving both the efficiency and security of banking systems. In today's digital environment, users expect fast, reliable, and secure services. A system that can meet these expectations is highly valuable.

The proposed system helps in reducing manual errors and improving data security. It also supports better financial understanding by providing insights into user spending patterns. This leads to improved user

satisfaction and more effective decision-making. Additionally, the system is useful for educational purposes and small-scale banking applications, where a simple yet secure solution is required.

By combining security features with financial analysis, the system provides a more complete and practical solution compared to traditional academic banking systems.

The scope of the system includes its use in educational environments, small-scale banking applications, and as a prototype for real-world implementation. The system covers user and administrator functionalities, including account management, transaction processing, security monitoring, and spending analysis.

It is designed to be simple, efficient, and easy to use, while still providing important features required in modern banking systems. Future improvements can include the integration of advanced technologies such as artificial intelligence, machine learning, and cloud-based services to further enhance system performance and scalability.

II. LITERATURE REVIEW

2.1 Summary of Existing Research

The research paper titled “Pattern-Based Internet Banking Architecture” (2012) explains how software design patterns are used to build secure and scalable internet banking systems. The study highlights that architecture plays a key role in defining system structure, reliability, and performance. It also explains that reusable patterns help developers create flexible and efficient banking applications by organizing components in a structured way . This work provides a strong foundation for designing modular banking systems.

The study “Intelligent Digital Banking” (2022) focuses on the transformation of traditional banking into smart digital platforms. It explains how technologies such as artificial intelligence and automation improve customer experience and operational efficiency. The research shows that modern banking systems are becoming more user-focused and data-driven, which supports the development of intelligent banking applications.

The research paper “Bank Management System” (JETIR, 2023) presents the development of a system that manages banking operations such as account handling, transactions, and security. It emphasizes the importance of system organization and data handling. This study is useful for understanding how different banking modules are connected to form a complete system.

The paper “Bank Management System” (IJRASET, 2025) explains how banking software is developed with proper database integration. It describes system architecture and explains how different modules interact with each other. The study highlights the importance of structured database design in managing financial data efficiently.

Another study titled “Bank Management System” (IJRDET, 2025) presents a detailed implementation of a banking system using modern programming techniques. It focuses on user authentication, transaction management, and system usability. The research explains how modular design and event-driven programming improve system performance and user experience .

The book “Bank 4.0: Banking Everywhere, Never at a Bank” by Brett King (2018) discusses the future of banking in a fully digital world. It explains how banking services are moving beyond physical branches and becoming available through mobile devices and online platforms. The book highlights the importance of customer-centric services and digital innovation.

The book “Cryptography and Network Security” by William Stallings provides detailed knowledge abo-

ut encryption, authentication, and secure communication. It explains how data can be protected from cyber threats, which is very important for banking systems that handle sensitive financial information.

The book "Patterns of Enterprise Application Architecture" by Martin Fowler explains how software design patterns are used in large applications. It helps developers build systems that are easy to maintain and expand. This is useful for designing the backend structure of banking systems.

The book "Database System Concepts" by Silberschatz, Korth, and Sudarshan explains how databases are designed and managed. It covers important topics such as data storage, queries, and transaction management. This knowledge is essential for handling banking data securely and efficiently.

The IEEE resource on "AI in Banking and Financial Services" explains how artificial intelligence is used in fraud detection, automation, and data analysis. It highlights the role of AI in improving banking security and decision-making processes.

The IBM document on "Cloud Computing for Banking" explains how cloud technology improves system scalability, storage, and performance. It allows banking systems to handle large amounts of data and users efficiently.

The research work on "Concurrency Control" by P. A. Bernstein explains how multiple transactions are managed in a database without errors. It ensures that data remains consistent even when many users access the system at the same time.

The report "Digital Banking Analytics Report" by McKinsey & Company provides insights into how banks use data analytics to understand customer behavior and improve services. It shows the importance of data-driven decision-making in modern banking.

The OWASP document on "Top 10 Security Risks" identifies common security issues in web applications. It helps developers understand vulnerabilities and build secure systems.

The guidelines provided by the Reserve Bank of India (RBI) explain the rules and standards for digital banking. These guidelines ensure that banking systems follow proper security and legal requirements.

2.2 Gaps Identified

After reviewing the existing research, it is observed that most studies focus mainly on basic banking operations such as account management and transaction processing. While some research includes security features, they often do not provide advanced mechanisms for detecting suspicious login activities in real time. Many systems lack intelligent monitoring that can analyze user behavior and identify potential threats.

Another important gap is the limited focus on user financial awareness. Most existing systems do not include features that help users understand their spending patterns. There is very little integration of analytics tools that provide insights into financial behavior.

Additionally, many research works focus either on system functionality or on technology aspects such as databases and architecture, but they do not combine security, analytics, and usability into a single system. This creates a need for a more integrated approach.

2.3 Problem Statement

Traditional banking systems are often slow, manual, and limited in functionality. Even modern digital banking systems mainly focus on basic operations and do not fully address security risks and user awareness. There is a lack of systems that can detect suspicious login activities based on user behavior and provide immediate response to potential threats.

At the same time, users do not have sufficient tools to analyze their spending habits and make better financial decisions. This creates a gap between banking services and user needs. Therefore, there is a

need to develop a system that not only performs banking operations efficiently but also improves security and provides meaningful financial insights.

2.4 Objectives

The main objective of this research is to design and develop a secure and intelligent Bank Management System that integrates core banking functionalities with advanced features. The system aims to provide efficient account management and transaction processing while ensuring strong security through mechanisms such as suspicious login detection.

Another objective is to include a smart spending analyzer that helps users understand their financial behavior. The system also aims to reduce manual work, improve accuracy, and enhance user experience through a simple and user-friendly interface.

Overall, the goal is to create a complete web-based banking solution that combines functionality, security, and analytics in a single platform.

III. METHODOLOGY

The methodology section explains the approach used to design, develop, and implement the proposed Bank Management System. It describes the research design, system architecture, development process, and techniques used to ensure security and efficiency. The system is developed as a web-based application using modern technologies to provide reliable and scalable banking services.

3.1 Research Design

The research follows a system development approach focused on designing a practical and functional banking application. The aim is to create a system that not only performs basic banking operations but also includes advanced features such as security monitoring and spending analysis.

The design process begins with understanding the requirements of users and administrators. Based on these requirements, the system is divided into different modules such as user management, account management, transaction processing, security monitoring, and analytics. Each module is developed and tested separately before integrating into the final system.

The research also includes analysis of existing banking systems to identify their limitations and improve upon them. This helps in designing a system that is more secure, efficient, and user-friendly.

3.2 System Architecture

The proposed system follows a three-layer architecture, which ensures proper organization and separation of functionalities. This architecture includes the presentation layer, application layer, and data layer.

The presentation layer is responsible for the user interface. It includes web pages developed using HTML, CSS, and templates, which allow users and administrators to interact with the system. The application layer handles the business logic of the system. It is implemented using the Flask framework, which processes user requests and performs required operations. The data layer is responsible for storing and managing data using the Oracle Database.

This layered architecture improves system performance, security, and maintainability. It also allows easy modification and future expansion of the system.

3.3 Development Approach

The system is developed using an incremental approach, where each module is implemented step by step. Initially, the user authentication module is developed to allow secure login and registration. After

that, account management features are implemented, followed by transaction processing functions such as deposit, withdrawal, and fund transfer.

Once the basic functionalities are completed, advanced features such as suspicious login detection and spending analysis are added. Each stage of development includes testing to ensure that the module works correctly before moving to the next stage. This approach helps in identifying and fixing errors early in the development process.

3.4 Database Design

The database plays an important role in the system as it stores all the information related to users, accounts, transactions, and login activities. The system uses Oracle Database to manage data efficiently and securely.

The database is designed using relational tables with proper constraints to maintain data integrity. Tables such as users, accounts, transactions, login logs, and administrators are created. Relationships between these tables are established using primary keys and foreign keys.

This structured design ensures that data is stored in an organized manner and can be retrieved quickly. It also helps in maintaining accuracy and consistency of information.

3.5 Security Implementation

Security is a key part of the system. The system uses password hashing to store user passwords securely. This ensures that passwords are not stored in plain text and cannot be easily accessed by unauthorized users.

The system also includes a suspicious login detection mechanism. It monitors user login behavior based on factors such as IP address, device information, login time, and number of failed attempts. If unusual activity is detected, the system can take appropriate actions such as restricting access or requiring additional verification.

These security measures help in protecting user data and preventing unauthorized access to the system.

3.6 Transaction Processing

The system provides core banking functionalities such as deposit, withdrawal, and fund transfer. Each transaction is recorded in the database with details such as amount, date, and type of transaction.

The system ensures that all transactions are processed accurately and that account balances are updated correctly. Proper validation is applied to prevent errors such as insufficient balance during withdrawal. This ensures reliability and consistency in financial operations.

3.7 Spending Analysis Method

The system includes a smart spending analyzer that helps users understand their financial behavior. Transaction data is categorized into different types such as expenses, savings, and transfers. The system then analyzes this data on a monthly basis.

The results are displayed using simple visual representations such as charts, which help users easily understand their spending patterns. This feature supports better financial planning and decision-making.

3.8 Testing and Validation

Testing is performed at each stage of development to ensure that the system works correctly. Different test cases are used to check user registration, login, account operations, and transaction processing.

The system is also tested for security by checking how it handles incorrect login attempts and suspicious activities. The results show that the system performs reliably and provides accurate outputs. Validation ensures that all modules work together smoothly in the final system.

IV. DATA ANALYSIS AND RESULTS

This section presents the analysis of the system performance and the results obtained after implementing the proposed Bank Management System. The analysis focuses on evaluating system functionality, security features, and the effectiveness of the spending analyzer. The results are based on practical testing of different modules under various conditions.

4.1 Functional Performance Analysis

The system was tested to evaluate its ability to perform core banking operations such as user registration, login, account creation, deposit, withdrawal, and fund transfer. The results show that the system performs these operations accurately and efficiently.

User registration and login processes were completed successfully with proper validation. The system correctly handled user inputs and ensured that only valid data was accepted. Account creation was also performed smoothly, and each account was assigned a unique identifier.

Transaction operations such as deposit and withdrawal were processed correctly, and account balances were updated in real time. The fund transfer feature ensured that the amount was deducted from one account and added to another without any errors. Overall, the system demonstrated reliable performance in handling banking operations.

4.2 Security Analysis

The security features of the system were tested to ensure protection against unauthorized access. Password hashing was successfully implemented, which ensured that user passwords were stored securely in encrypted form.

The suspicious login detection module was tested under different scenarios. When normal login behavior was observed, the system allowed access without interruption. However, when unusual patterns such as multiple failed attempts or login from unknown devices were detected, the system identified the activity as suspicious.

In such cases, appropriate actions were triggered, such as restricting access or requiring additional verification. This shows that the system is capable of detecting potential threats and improving overall security.

4.3 Transaction Accuracy and Consistency

The system was evaluated for its ability to maintain accurate and consistent transaction records. Each transaction was recorded with details such as transaction type, amount, and time.

The system ensured that account balances were updated correctly after every transaction. Tests were conducted to verify scenarios such as insufficient balance during withdrawal, and the system successfully prevented invalid transactions.

Data consistency was maintained across all modules, and no mismatch in transaction records was observed. This confirms that the system provides reliable financial operations.

4.4 Spending Analysis Results

The smart spending analyzer was tested using sample transaction data. The system categorized transactions into different groups and analyzed monthly spending patterns.

The results were displayed in a clear and understandable format using graphical representations. Users were able to identify their spending habits and observe how much they spent in different categories.

The system also helped in identifying high spending patterns, which can assist users in better financial planning. This feature adds value by providing useful insights beyond basic banking operations.

4.5 System Usability and Efficiency

The overall usability of the system was evaluated based on user interaction and response time. The interface was found to be simple and user-friendly, allowing users to perform tasks easily without confusion.

The system responded quickly to user requests, and most operations were completed without delay. The use of a web-based platform allowed easy access from different devices, which improved convenience for users.

The integration of different modules worked smoothly, and the system operated efficiently under normal conditions.

4.6 Observations

The analysis of the system shows that it successfully combines core banking functionalities with advanced features such as security monitoring and spending analysis. The system reduces manual effort, improves accuracy, and enhances user experience.

It was observed that the security module plays an important role in protecting user accounts, while the spending analyzer helps users gain better control over their finances. The system demonstrates a balanced approach between functionality and security.

4.7 Summary of Results

The overall results indicate that the proposed Bank Management System performs effectively and meets its objectives. It provides accurate transaction processing, strong security measures, and useful analytical features.

The system is suitable for educational purposes and small-scale applications, and it can be further improved by adding advanced technologies in the future.

IV. RESULTS AND DISCUSSION

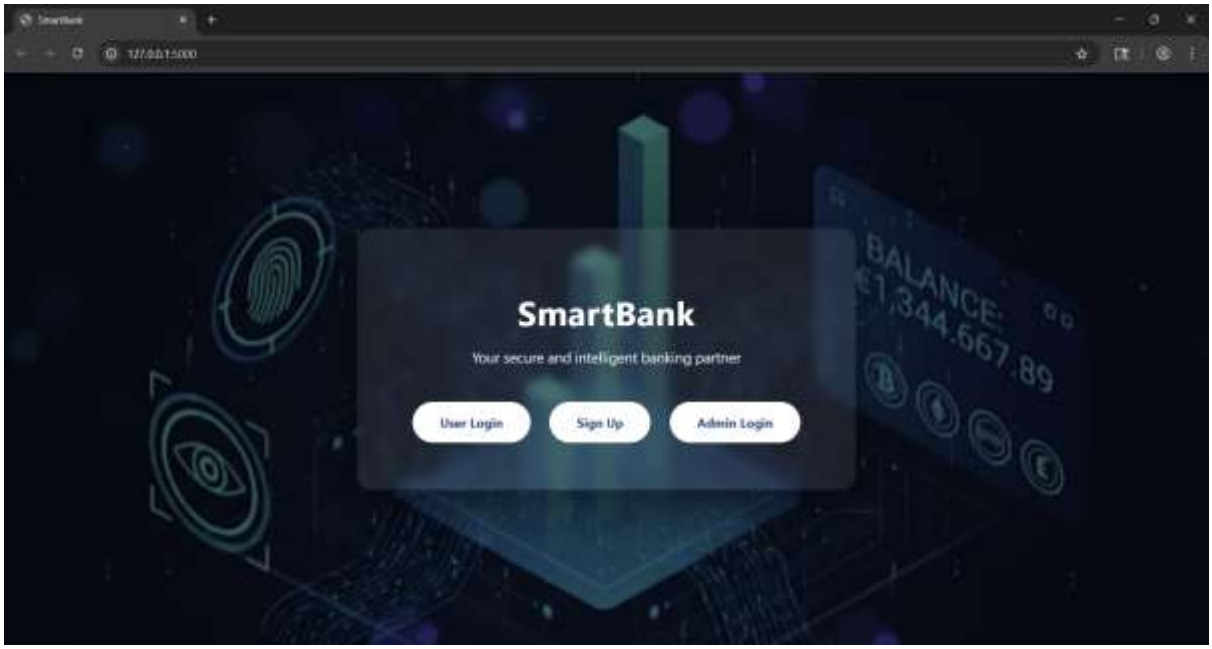

Fig. 3 Home page

Figure 3 Home Page represents the Home Page of the Smart Bank Management System developed using Flask and connected to Oracle Database. This page serves as the main entry point of the application.

The interface displays the title “SmartBank” along with a tagline that highlights it as a secure and intelligent banking partner. The background design includes digital and security-related visuals, which reflect the concept of modern online banking.

At the center of the page, three options are provided for navigation. The User Login option is used by existing users to access their accounts. The Sign Up option allows new users to register in the system. The Admin Login option is provided for administrators to log in and manage the system.

This page is designed to be simple, clear, and user-friendly, enabling users and administrators to easily access different functionalities of the banking system.

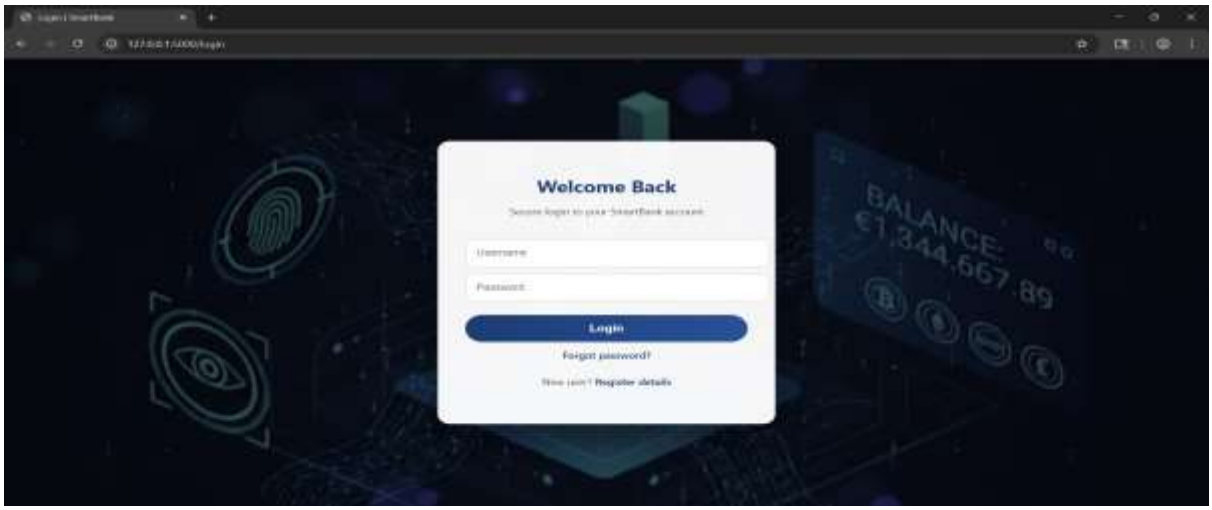

Fig. 4 User login Page

User Login Page of the SmartBank web application. This interface provides a secure access point where users enter their username and password to log into the system. The page is designed with a simple and user-friendly layout that includes input fields for credentials and a login button for authentication. It also provides options such as “Forgot password” for account recovery and “Register details” for new users. The background design represents digital security elements, indicating the system’s focus on safe and modern banking access.

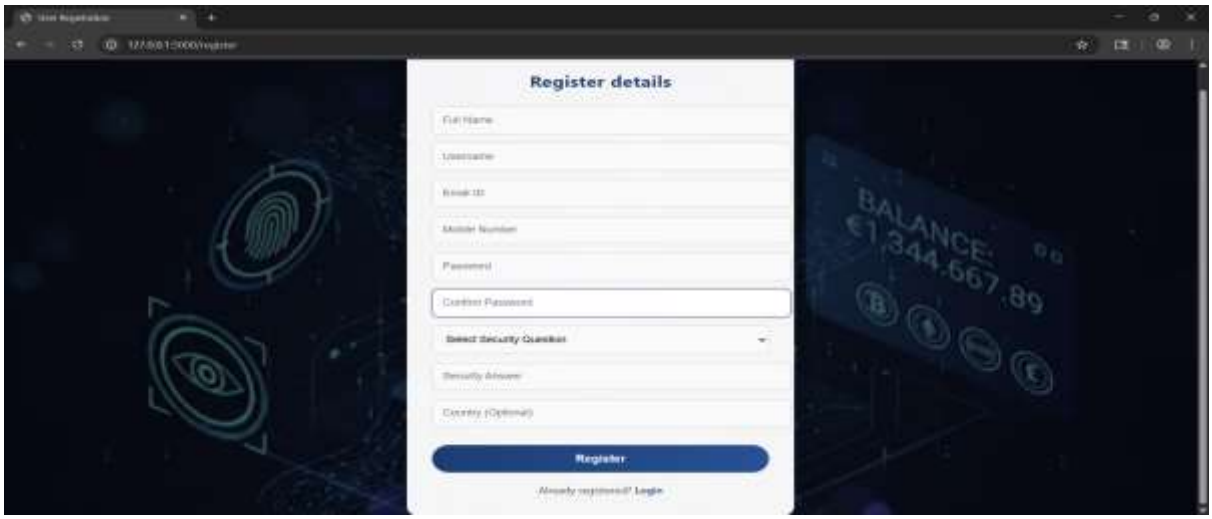

Fig. 5 Signup Page

Signup Page of the SmartBank web application. This interface allows new users to register by entering details such as full name, username, email ID, mobile number, and password. It also includes additional security features like password confirmation and selection of a security question with an answer for account recovery. The page is designed to ensure proper input validation so that accurate and complete information is submitted. This registration process helps in securely creating user accounts and storing their data in the system database.

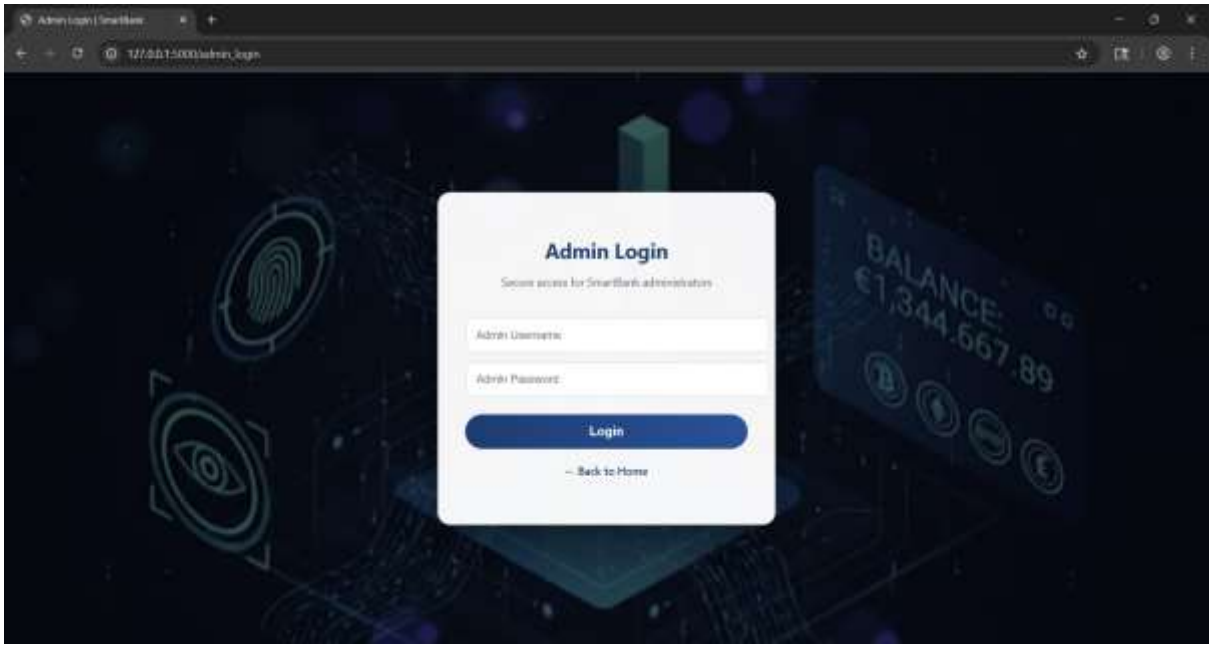

Fig. 6 Admin login

Admin Login Page of the SmartBank web application. This interface provides secure access for system administrators to log into the system using an admin username and password. The page is designed with a simple and clear layout to ensure easy authentication. It includes a login button to validate credentials and a navigation option to return to the home page. This page is important for restricting access to administrative functions and maintaining system control and security.

Fig. 7 User dashboard

The figure User dashboard illustrates the User Dashboard of a Bank Management System, which serves as the main interface after a user successfully logs into the application. At the top of the screen, a personalized welcome message is displayed, addressing the user as “Welcome, Pratibha Parmeshwar Petkar!”, indicating that the system provides customized access. On the top-right side, a Logout button is available, allowing the user to safely exit the system.

The left side of the screen contains a vertical navigation panel with various modules that help the user perform different banking operations. These modules include options for managing user security, profile details, bank accounts, transactions, and analyzing spending patterns. This layout ensures easy and organized navigation within the system.

The central area of the dashboard is kept simple and currently displays a message instructing the user to select a module from the left menu to proceed. This shows that the dashboard is dynamic, and the content will change depending on the user’s selection. Overall, the design of the dashboard is clean, structured, and user-friendly, making it easy for users to access and manage different banking services efficiently.

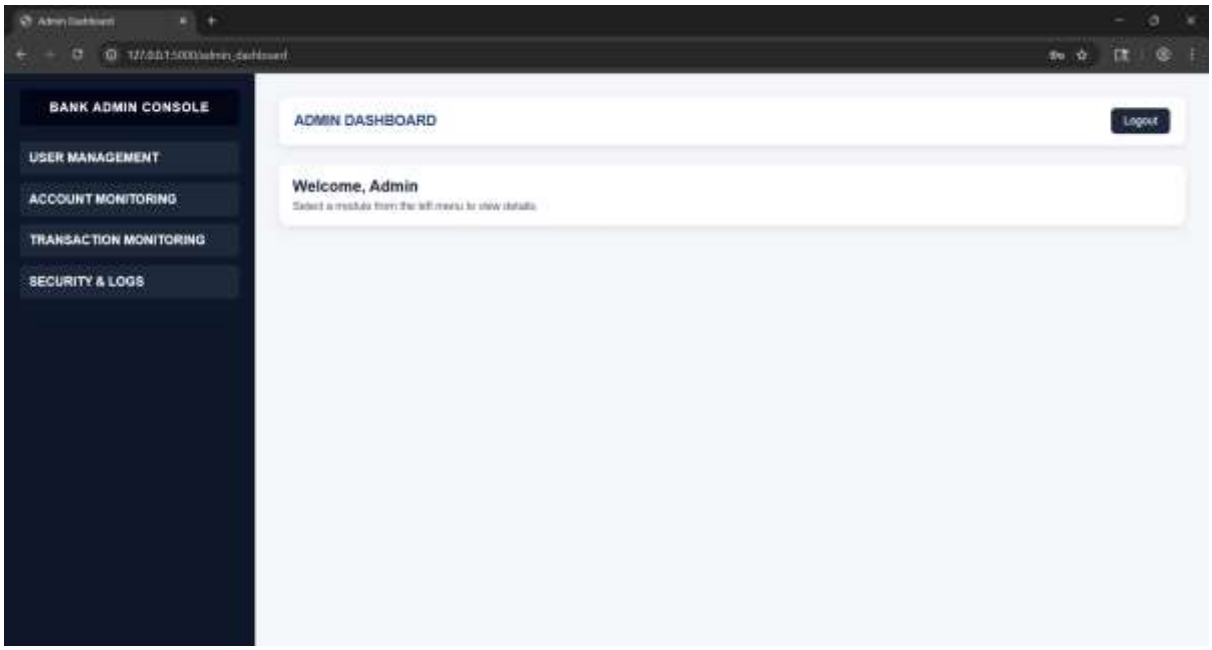

Fig. 8 Admin Dashboard

Admin Dashboard shows a web-based banking administration interface designed for system control and monitoring. The screen is divided into two main sections: a dark-colored left sidebar and a main content area on the right. The sidebar contains the title “Bank Admin Console” along with navigation options such as User Management, Account Monitoring, Transaction Monitoring, and Security & Logs, allowing the administrator to access different system functionalities easily.

The main panel displays the heading “Admin Dashboard” at the top with a Logout button placed on the right side for secure session termination. Below the header, a welcome message “Welcome, Admin” is shown, guiding the user to select a module from the menu to view details. The layout is clean and structured, providing a user-friendly interface for managing banking operations efficiently while ensuring quick access to important administrative tasks.

V. CONCLUSION

The results of the proposed system highlight the importance of combining functionality, security, and analytics in modern banking applications. The system successfully demonstrates how a web-based platform can handle banking operations while also providing additional features such as suspicious login detection and spending analysis.

One of the key observations is that security plays a critical role in user trust. The implementation of password hashing and login monitoring improves the reliability of the system. At the same time, the inclusion of spending analysis adds value by helping users understand their financial behavior.

The system also shows that automation reduces manual effort and improves accuracy. However, there are certain limitations, such as the use of basic predictive methods and limited scalability for large-scale applications. These limitations can be addressed in future versions by using advanced technologies.

Overall, the system provides a balanced approach by integrating core banking operations with modern features. It demonstrates how technology can be used to improve both system performance and user experience

The proposed Bank Management System provides a complete solution for managing banking operations in a secure and efficient manner. The system successfully performs core functions such as account management, deposits, withdrawals, and fund transfers.

In addition to basic functionalities, the system includes advanced features such as suspicious login detection and a smart spending analyzer. These features improve security and help users make better financial decisions. The use of Flask and Oracle Database ensures that the system is reliable, scalable, and easy to use.

The results show that the system reduces manual work, improves accuracy, and enhances transparency. It is suitable for educational purposes and small-scale applications. With further improvements, the system can be extended to handle more complex banking requirements.

In conclusion, the project demonstrates the effective use of modern technologies to develop a secure and user-friendly banking system. It provides a strong foundation for future enhancements and real-world implementation.

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