

**AN AI-MOBILE-BASED PERSONAL FINANCE MANAGEMENT AND
BUDGETING SYSTEM CASE STUDY: UGANDA CHRISTIAN UNIVERSITY
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**A DISSERTATION SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND
TECHNOLOGY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD
OF A DEGREE OF BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY OF
UGANDA CHRISTIAN UNIVERSITY**

May, 2026



**UGANDA CHRISTIAN
UNIVERSITY**

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DECLARATION

We, the undersigned, declare that the content of this report is original and has not been submitted to any other educational institution for academic credit. This work is the result of our own research, effort, and collaboration.

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DEDICATION

This project is dedicated to all individuals who strive to improve financial literacy and promote responsible money management, especially among young people. To the financial professionals and educators who work tirelessly to guide individuals in making better financial decisions, your dedication inspires us to develop solutions that support financial empowerment.

We also dedicate this project to the youth who face challenges in managing their finances in a rapidly changing digital economy. Your determination to achieve financial stability motivates us to create tools that help individuals plan, save, and make informed financial choices.

With great appreciation, we dedicate this project to our friends and colleagues who provided encouragement, advice, and support throughout the development of this project.

Finally, we express our deepest gratitude to our parents and guardians for their unconditional love, guidance, and support throughout our academic journey. Their encouragement and belief in us made the completion of this project possible

ACKNOWLEDGEMENT

First and foremost, we give our deepest thanks and praise to the Almighty God for granting us the strength, wisdom, and opportunity to successfully complete this project.

We would also like to express our sincere gratitude to our esteemed lecturers and supervisors, Madam Justine Mukalere and Mr. Opio Solomon and MADAM Daphne BITALO Nyachaki, for their invaluable guidance, encouragement, and continuous support throughout the development of this project. Their expertise, advice, and dedication greatly contributed to shaping our ideas and improving the quality of this work.

We also extend our appreciation to the financial professionals and institutions who provided valuable insights during our research. Their contributions helped us better understand the financial challenges faced by young people and guided the development of the PesaPath financial management system.

we would like to thank our parents, guardians, and friends for their continuous support, encouragement, and prayers throughout our academic journey. Their motivation and belief in us made the successful completion of this project possible.

Uganda Christian University for providing the academic support and the ground upon which this project has been based.

The Computing Department of Uganda Christian University for giving us the technical competence and understanding required to bring PESAPATH into being. Every one of you made it all possible. For coming with us on our journey to build solutions for Uganda's young people

PREFACE

Financial management remains a significant challenge for many young people, especially in developing countries where financial literacy and access to effective financial planning tools are limited. In Uganda, although digital financial services such as mobile money and online banking have become widely available, many youths still struggle with budgeting, saving, and making informed financial decisions.

The PesaPath project was developed in response to these challenges and aims to leverage modern digital technologies to promote better financial management among young people. This project introduces an AI-powered financial platform designed to help users plan their finances, track expenses, set savings goals, and receive personalized financial guidance.

Through the collaborative efforts of our project team, PesaPath seeks to support financial literacy and encourage responsible financial habits among youth. By combining financial education, budgeting tools, and intelligent digital assistance, the system aims to empower individuals to make better financial decisions and improve their long-term financial well-being.

This preface introduces the motivation, objectives, and vision behind the development of PesaPath and provides a foundation for the detailed discussion of the system presented in the following chapter

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Abbreviations (Acronyms)

AI – Artificial Intelligence

API – Application Programming Interface

UI – User Interface

UX – User Experience

SQL – Structured Query Language

CSS – Cascading Style Sheets

JWT – JSON Web Token

2FA – Two-Factor Authentication

SACCO – Savings and Credit Cooperative Organization

LLM – Large Language Model

ABSTRACT

The PesaPath project was developed to improve financial literacy, budgeting, and money management skills among Ugandan youth, addressing challenges such as low financial knowledge, impulsive spending, and limited access to secure digital financial tools. Despite over 30 million Ugandans using mobile money platforms like MTN Mobile Money and Airtel Money, only about 30% of youth understand basic financial concepts, and financial literacy among young people is estimated at just 1%. The study employed a mixed-methods approach, collecting qualitative insights from financial experts at Equity Bank, UAP Insurance, Post Bank, and MasterCard Foundation, alongside quantitative data from 200 youth through structured questionnaires. These findings guided the design and development of a cross-platform mobile application leveraging React, Typescript, Firebase, and AI modules to provide personalized financial guidance, savings tracking, budgeting tips, and educational content. PesaPath operates in online, offline, and USSD modes to ensure accessibility for users with diverse technology access levels. Testing with 150–200 youth demonstrated improved financial knowledge, positive behavior changes in spending and saving, and high user engagement. The project highlights the significance of integrating AI-driven financial advisory, gamified learning, and inclusive technology to address gaps in financial literacy, offering a scalable and practical solution to empower Ugandan youth to make informed financial decisions.

Chapter One: Introduction

1.1 Background

Financial literacy and effective money management have remained significant challenges among young people in Uganda, particularly those living in underserved and rural communities. Over the years, access to financial services has expanded through the rapid growth of mobile money platforms such as MTN Mobile Money and Airtel Money. However, this increased access has not translated into improved financial management skills among the youth.

Studies have indicated that a large proportion of young Ugandans have lacked basic financial knowledge and skills necessary for effective budgeting, saving, and responsible borrowing. According to the Bank of Uganda (2022), less than 35% of Ugandan youth have demonstrated basic financial literacy, while a report by UAP Old Mutual has estimated that only about 1% of young people have possessed advanced financial literacy skills. This gap has resulted in widespread challenges such as impulsive spending, poor saving habits, and limited long-term financial planning.

Furthermore, research conducted by the Fin Scope Uganda Survey (2018) has shown that although over 70% of Ugandans have accessed financial services, the majority have primarily used them for transactions rather than for structured financial planning. This has highlighted a critical disconnect between access to financial tools and the ability to use them effectively for wealth creation and financial stability.

In addition, structural barriers have continued to limit the effective adoption of digital financial solutions. Limited smartphone penetration, high internet costs, and low levels of digital literacy have constrained many young people from fully participating in digital financial ecosystems. According to the Uganda Communications Commission (2023), smartphone penetration in Uganda has remained below 40%, further restricting access to advanced financial management applications.

Given these persistent challenges, there has been an increasing need to leverage technology to bridge the gap between financial access and financial literacy. Digital platforms have emerged as promising tools for delivering practical, accessible, and personalized financial education. In particular, the integration of Artificial Intelligence (AI) has enabled systems to provide real-time insights, automate financial tracking, and offer tailored financial advice based on user behavior.

The PesaPath initiative has been developed in response to these challenges, with the aim of transforming financial behavior among Ugandan youth. The platform has been designed as an AI-powered solution that integrates budgeting, saving, and expense tracking functionalities while delivering personalized financial guidance. By combining financial education with practical tools, PesaPath has sought to promote responsible spending, improve saving habits, and empower young people to make informed financial decisions.

Therefore, this study has been grounded in the need to address the persistent gaps in financial literacy and digital financial management among Ugandan youth through an innovative, technology-driven approach.

1.2 Problem Statement

Many people, especially students and young professionals in Uganda, have faced challenges in managing their personal finances. Although financial services like mobile money have become widely available, many individuals have not developed the skills needed to budget, save, and track their expenses properly.

Studies have shown that a large number of people have not used any formal budgeting methods. According to the World Bank, more than 60% of individuals in developing countries have had low financial literacy. This has made it difficult for them to make good financial decisions. In addition, reports from UAP Old Mutual have indicated that many people have struggled to consistently track their spending and savings.

Because of this, many individuals have experienced problems such as overspending, lack of savings, and financial stress. Some have even depended on borrowing due to poor financial

planning. In Uganda, the Fin Scope Uganda Survey has shown that although many people use financial services, they mainly use them for sending and receiving money, not for planning or managing their finances.

Another major issue is that many people have relied on manual methods like notebooks or memory to manage their money. These methods have often led to mistakes, poor tracking, and bad financial decisions. At the same time, there have been very few simple and user-friendly digital tools to help people manage their finances effectively.

Because of these challenges, many individuals have not been able to set financial goals, track their progress, or improve their financial situation.

Therefore, there has been a need for a simple and accessible digital solution that can help people manage their money better. The PesaPath system has been developed to solve this problem by helping users budget, track expenses, and plan their finances more easily, so they can make better financial decisions and improve their financial well-being.

1.3 Aims / Objectives

1.3.1 Main Objective

To develop an AI-powered digital platform that improves financial management skills and supports informed financial decision-making among young people in Uganda.

1.3.2 Specific Objectives

- To implement budgeting and expense tracking features that allow users to efficiently monitor their income, spending patterns, and savings progress.
- To develop an AI-driven chatbot that provides personalized financial guidance, recommendations, and answers to users' finance-related questions.
- To design and integrate an in-app financial academy that educates users on personal finance, investment principles, and money management strategies.

- To encourage responsible financial behavior by providing timely tips, notifications, and gamified elements that motivate users to save, budget, and spend wisely.

1.4 Project Scope and limitations

1.4.1 Project scope

The scope of this project focused on the development, deployment, and future improvement of the PesaPath financial management system after it was successfully designed and implemented. The system was developed to support better financial management among Ugandan youth by providing tools for budgeting, expense tracking, savings management, and financial education.

PesaPath was designed as a digital platform that allowed users to record their expenses, create budgets, track their savings, and receive personalized financial guidance. The platform also provided simple financial education resources to help users improve their financial literacy and make better financial decisions.

The operational scope included the following:

- The system was deployed on a reliable hosting environment to ensure continuous access for users.
- System performance and availability were monitored to ensure that users could access the platform smoothly and efficiently.
- Regular data backups were implemented to protect user financial data and ensure data recovery in case of system failure.
- Technical support was provided to address user challenges and ensure the platform functioned effectively.

The maintenance scope included:

- Regular system updates were carried out to fix software bugs, improve performance, and enhance system features.
- The database was monitored and optimized to ensure efficient storage and retrieval of users' financial records such as expenses and savings data.

- Security measures were maintained to protect user financial information and ensure data privacy.

The enhancement scope included:

- Continuous improvement of the user interface and user experience based on feedback from users and system testing.
- Integration of additional financial tools and features to improve the functionality of the platform.
- Exploration of Artificial Intelligence (AI) capabilities to provide more accurate and personalized financial advice to users based on their spending and saving patterns.
- Further development of financial education content to help users better understand budgeting, saving, and responsible financial management.

1.4.2 Limitations

Despite the successful development of the PesaPath system, several limitations were identified during the project:

- Some users required additional training to fully understand how to use the financial management features of the system.
- Limited time and resources affected the depth of system testing and research during the development process.
- Concerns about financial data privacy required strong security measures to protect user information.
- Managing the scope of the project was sometimes challenging as new feature ideas emerged during development.
- Dependence on internet connectivity could affect system accessibility for users in areas with poor network coverage.
- Testing constraints may have limited the ability to fully evaluate the system under all real-world usage conditions.

1.4.3 Importance and relevance of the project

The PesaPath platform was significant because it addressed key challenges related to financial management and financial literacy among Ugandan youth. Many young people often struggled with budgeting, saving money, and managing their daily expenses due to limited financial knowledge and lack of practical financial management tools. The system therefore played an important role in promoting responsible financial behavior through a simple and accessible digital platform.

The system enabled users to track their expenses, create budgets, and set savings goals, which helped them better understand how they managed their money. By providing these financial management tools in one platform, PesaPath helped users develop healthier financial habits and make more informed financial decisions.

Through its financial education features, the platform provided users with simple learning resources and practical tips on topics such as saving, budgeting, and responsible spending. This helped improve financial literacy and increased users' confidence in managing their personal finances.

The system also incorporated Artificial Intelligence (AI) to provide personalized financial guidance based on users' spending patterns and financial behavior. This allowed users to receive customized recommendations that helped them reduce unnecessary spending, increase savings, and improve their overall financial planning.

By leveraging digital technology, PesaPath reduced the complexity of financial management and made financial tools more accessible and affordable for young people. As a result, the platform contributed to improving financial awareness, encouraging better money management practices, and supporting long-term financial stability among its users

Chapter two: Literature Review

2.1 Introduction

This chapter reviews existing literature on financial literacy, digital financial services, and personal finance management systems. It explores the global, African, and Ugandan perspectives, highlighting key trends, challenges, and gaps in existing solutions. The chapter also explains how the PesaPath system addresses these gaps by integrating financial education, budgeting tools, and artificial intelligence into one platform.

2.2 Global Context of Financial Literacy and Digital Finance

Globally, financial literacy is widely recognized as a critical factor in improving individuals' financial well-being. Financial literacy refers to the ability to understand and effectively use financial skills such as budgeting, saving, investing, and financial planning.

According to the World Bank (2023), access to financial services has significantly improved worldwide due to the growth of digital financial technologies. However, many individuals still lack the knowledge required to manage their finances effectively. This has resulted in increased financial vulnerability, poor saving habits, and over-reliance on credit.

The Organisation for Economic Co-operation and Development (2021) emphasizes that financial education plays a key role in helping individuals make informed financial decisions, manage risks, and plan for long-term goals such as investments and retirement. The report further highlights that digital platforms that combine financial tools with education are more effective in improving user financial behavior compared to traditional methods.

In addition, recent global trends show increasing use of Artificial Intelligence (AI) in financial services. AI is being used to provide personalized recommendations, detect spending patterns, and support decision-making. However, many AI-based financial tools are still limited to developed countries, leaving a gap in developing regions.

2.3 African Context

In Africa, the adoption of digital financial services has grown rapidly, especially through mobile money platforms. According to the GSMA (2023), Sub-Saharan Africa is the global leader in mobile

money usage, with millions of active users relying on mobile platforms for daily financial transactions.

Despite this growth, financial literacy levels remain low across many African countries. Many users primarily use mobile money for sending and receiving money, but lack knowledge on how to save, invest, or manage their finances effectively. This has contributed to continued financial instability and limited economic growth among individuals.

Furthermore, most financial technology (Fintech) solutions in Africa are focused on payment systems, digital lending, and remittances. While these services improve financial access, they do not adequately address the issue of financial education or behavior change.

Studies also indicate that young people in Africa are particularly affected by poor financial habits due to limited access to financial education and guidance. This creates a need for solutions that not only provide financial services but also improve financial knowledge and decision-making.

2.4 Ugandan Context

Uganda has experienced significant growth in digital financial services, especially mobile money. The Bank of Uganda (2023) reports that over **70% of Ugandan adults actively use mobile money services**, making it one of the most widely used financial tools in the country.

However, despite this high level of access, the World Bank (2023) indicates that only about **34% of adults in Uganda have formal savings**. This shows that many users are not using financial services for long-term financial planning or wealth creation.

The Uganda Bureau of Statistics (2022) further reports that over **75% of Uganda's population is under the age of 30**, meaning that youth form the largest and most economically active group. Despite this, many young people lack financial literacy, leading to poor budgeting, overspending, and reliance on mobile loans.

Additionally, there is limited integration of financial education within digital financial platforms in Uganda. Most available applications focus on transactions, leaving a gap in financial learning and personalized financial support.

2.5 Existing Systems and Technologies

Several financial applications exist both globally and locally, including mobile banking apps, mobile money platforms, and budgeting tools. These systems mainly support:

- Sending and receiving money
- Paying bills and making transactions
- Accessing loans and credit services

However, these systems have several limitations:

- They do not provide **personalized financial advice**
- They lack **interactive financial education**
- They do not actively **guide users in decision-making**
- They are not designed to **change user financial behavior**

In addition, most systems do not use advanced technologies such as AI to analyze user behavior and provide real-time recommendations.

2.6 Research Gaps

Based on the reviewed literature, the following gaps have been identified:

1. **Lack of integrated financial solutions**

Existing systems separate budgeting, education, and advisory services instead of combining them into one platform.

2. **Limited financial education in digital platforms**

Most applications do not include structured learning materials or financial literacy programs.

3. **Lack of personalized financial guidance**

Few systems provide advice tailored to individual user behavior and financial patterns.

4. **Underutilization of AI in personal finance**

There is limited use of AI to provide intelligent insights and predictive financial support.

5. **Insufficient focus on youth**

Many solutions are not specifically designed to address the financial challenges faced by young people.

2.7 How PesaPath Addresses These Gaps

The PesaPath system was developed to address the identified gaps by providing a comprehensive and intelligent financial management platform.

The system integrates:

- **Budgeting and expense tracking tools** to help users monitor their finances
- **AI-based financial advice** using Google Gemini AI to provide personalized recommendations
- **An in-app financial learning platform** to improve financial literacy
- **Gamification features** to encourage positive financial behavior

Unlike existing systems, PesaPath combines all these features into a single platform, making it easier for users to manage their finances, learn financial skills, and make informed decisions.

The use of AI allows the system to analyze user data and provide real-time insights, helping users improve their saving habits and financial planning.

This integrated approach makes PesaPath a practical and effective solution for improving financial literacy and financial management among young people in Uganda.

Chapter Three: Methodology

This study adopted a mixed-method approach combining qualitative and quantitative research methods to ensure a comprehensive understanding of user financial behavior. Agile methodology was used to guide system development, allowing structured planning alongside iterative improvements.

To achieve the objective of implementing effective budgeting and expense tracking features, data was collected through questionnaires distributed to young adults in Kampala and Uganda Christian University. This helped analyze users' spending habits, income patterns, and saving behaviors.

To support the development of an AI-based financial advisory system, interviews were conducted with financial professionals from Equity Bank, UAP Insurance, and Postbank. These interviews provided expert insights into common financial challenges and informed the design of the AI chatbot.

For the design and integration of the financial learning platform, both user data and expert knowledge were analyzed to identify gaps in financial literacy and determine relevant learning content.

The system was then developed using Typescript, React Native, and Next.js for application development, Firebase and MySQL for data storage, and Genk it integrated with Google Gemini AI to power intelligent financial recommendations.

3.1 Description of the approach used in the project

The PesaPath project adopted an **Agile development approach** to ensure that the system was built efficiently while meeting the needs of young people in Uganda. Agile methodology allowed the team to work in iterative cycles, continuously improving the platform based on feedback and testing results. This approach was well-suited for developing an AI-powered financial management system that included budgeting, expense tracking, financial education, and personalized guidance.

At the start of the project, the team conducted **requirement analysis** to clearly understand the objectives of the platform, which were:

1. To implement budgeting and expense tracking features.
2. To develop an AI-based chatbot providing personalized financial advice.
3. To design and integrate an in-app financial academy.
4. To promote responsible financial behavior through tips, alerts, and gamification.

Following this, the system was developed in **sprints**, where each sprint focused on a specific component of the platform. For example, one sprint was dedicated to designing and implementing budgeting and expense tracking tools, while another focused on integrating the AI chatbot for personalized financial recommendations. The iterative process allowed the team to test features continuously, gather user feedback, and make improvements quickly.

To collect data for the development process, **questionnaires** were distributed to young adults in Kampala and at Uganda Christian University. This helped analyze users' income patterns, spending habits, and saving behaviors, which guided the design of the budgeting and expense tracking features. Additionally, **interviews with financial professionals** from Equity Bank, UAP Insurance, and Postbank provided expert insights into common financial challenges, which informed the development of the AI-based financial advisory system.

For the **financial learning platform**, both user data and expert knowledge were analyzed to identify gaps in financial literacy and determine relevant learning content.

The system was developed using **Typescript, React Native, and Next.js** for the frontend and mobile application, **Firebase and MySQL** for data storage, and **Genk it integrated with Google Gemini AI** to power intelligent financial recommendations.

Using Agile methodology allowed the team to:

- Prioritize the most important features first, such as budgeting and expense tracking.
- Continuously test and refine features for better usability and performance.
- Integrate additional improvements, including AI guidance and gamified financial tips, during later sprints.

- Collaborate effectively using shared tools and version control systems.

Overall, the Agile approach ensured that the PesaPath system was developed efficiently, aligned with its objectives, and responsive to users' needs.

3.2 Tools, technologies and methodologies used.

The development of the PesaPath platform incorporated a range of modern technologies to ensure scalability, security, efficiency, and an enhanced user experience. Each technology was carefully selected to fulfill specific system requirements across the frontend, backend, data management, and intelligent processing layers.

1. React Native

React Native was utilized as the primary frontend framework for developing the mobile user interface of the PesaPath platform. It is a widely adopted JavaScript framework for building cross-platform mobile applications.

Its component-based architecture enabled the creation of reusable and modular user interface elements, including dashboards, budgeting modules, expense tracking forms, and financial education sections. React Native contributed to a responsive, intuitive, and consistent user experience across mobile devices.

2. Firebase

Firebase served as the core backend platform for the system, providing a comprehensive Backend-as-a-Service (BaaS) solution. It offers integrated services such as authentication, cloud data storage, and real-time synchronization.

By leveraging Firebase, the development process was streamlined, eliminating the need for managing traditional server infrastructure while ensuring high availability, scalability, and secure data handling.

3. Firebase Authentication

Firebase Authentication was implemented to manage user identity and access control within the system. It supports secure user registration and login using email and password credentials.

This service ensured that user data remains protected and accessible only to authorized individuals, thereby enhancing the overall security and integrity of the platform.

4. Cloud Fire store

Cloud Fire store was employed as the primary database for the application. It is a scalable, NoSQL document-based database that supports real-time data updates.

Within the PesaPath platform, Fire store stores essential data such as user profiles, transaction records, budgeting information, savings goals, and financial activity history. Its real-time capabilities allow users to instantly view updates, thereby improving system responsiveness and usability.

5. Tailwind CSS

Tailwind CSS was used as the styling framework for designing the application's user interface. As a utility-first CSS framework, it provides pre-defined classes that facilitate rapid development of modern, responsive, and consistent layouts.

It enabled efficient styling of key interface components, including dashboards, financial tracking pages, and educational content sections.

6. Swagger UI

Swagger UI was utilized for API documentation and testing during the development process. It generates interactive and user-friendly documentation for application interfaces.

This tool simplified the testing of endpoints, validation of responses, and ensured seamless communication between system components, thereby improving development efficiency and reliability.

7. Google Gemini AI

Google Gemini AI was integrated into the system to provide intelligent and personalized financial guidance. The AI component analyzes user financial behavior, including spending patterns, budgeting habits, and savings trends.

Based on this analysis, the system generates data-driven recommendations that assist users in making informed financial decisions and improving their overall financial management.

8. GitHub

GitHub was employed as the version control and collaboration platform for the project. It enabled efficient management of the source code, tracking of changes, and coordination among development team members.

Personalized Financial Advice

This facilitated organized development workflows, ensured code integrity, and supported collaborative contributions throughout the project lifecycle.

AI-Based Financial Advisory Model

The proposed system incorporates three analytical modules to generate personalized financial insights and recommendations:

1. Transaction Pattern Analysis (Anomaly & Behavioral Detection Module)

The system analyzes a rolling window of recent user transactions (e.g., last 20 entries) to identify recurring micro-expenditures using pattern recognition techniques.

Technical Logic:

Applies frequency analysis and clustering to detect repetitive low-value transactions.

Aggregates these transactions over time to estimate cumulative financial impact.

Flags non-essential spending patterns as potential “financial leaks.”

Output:

Provides optimization recommendations, such as substituting high-frequency micro-transactions with cost-efficient alternatives (e.g., bundled services), along with estimated monthly savings.

2. Opportunity Cost Evaluation (Market Comparison Engine)

The system integrates external financial data (e.g., interest rates from the Bank of Uganda) to evaluate the opportunity cost of idle funds.

Technical Logic:

Compares returns from low-yield holdings (e.g., mobile money balances at ~0% interest) against alternative investment instruments (e.g., Treasury Bonds).

Uses basic financial models to project potential earnings over a defined period.

Output:

Generates actionable insights quantifying unrealized gains and recommends optimal asset reallocation strategies to maximize returns.

3. Personalized Portfolio Recommendation (Rule-Based + Heuristic Engine)

The system generates a simplified investment allocation strategy based on user demographics (e.g., age) and financial goals.

Technical Logic:

Implements rule-based decision models combined with heuristic guidelines (e.g., life-cycle investment theory).

Classifies users into risk profiles (e.g., growth-oriented vs. conservative).

Allocates asset distribution accordingly.

Output:

Produces a structured investment roadmap, specifying percentage allocations across financial instruments (e.g., Unit Trusts for liquidity and Bonds for long-term stability).

3.3 The Development process

The PesaPath project was developed using the Agile methodology, which focuses on iterative development, continuous feedback, and flexibility to adapt to changing requirements. The development began with a requirements-gathering phase, during which the team collected, analyzed, and documented the financial management needs and preferences of young people in Uganda.

Next, the team moved into the design phase, creating wireframes, prototypes, and system architecture diagrams to visualize the solution. These design artifacts guided the development of the user interface, budgeting and expense tracking modules, AI-driven personalized financial guidance, and other core features of the platform.

The system was then developed in sprints, where each sprint focused on implementing and testing specific features. This iterative process allowed the team to incorporate feedback from user testing continuously, refining features for better usability, performance, and engagement.

Using Agile methodology ensured that PesaPath was flexible, reliable, and responsive to the financial management needs of its target users, while allowing the team to prioritize key functionalities such as budgeting, expense tracking, financial education, and AI-based financial advice.

Chapter Four: System Design and analysis

4.1 Architectural Overview

The PesaPath Platform uses a client–server architecture that enables users to perform digital financial transactions such as sending money, receiving payments, and managing digital wallets through an online system. In this design, the client-side application communicates with cloud-based backend services to process requests, manage transactions, and securely store user data.

The system architecture is organized into three main layers: Presentation Layer, Application Layer, and Data Layer.

Presentation Layer

The Presentation Layer represents the frontend interface where users interact with the PesaPath platform. It includes the User Portal and Admin Portal, which provide access to financial services and system management features.

The frontend is developed using modern web technologies such as Typescript, React, and Tailwind CSS, which ensure a responsive, fast, and user-friendly interface.

User Portal

The User Portal allows customers to perform financial activities using the PesaPath system.

Key features include:

- Dashboard – Displays wallet balance and recent transactions.
- Send Money – Allows users to transfer money to other users within the system.
- Receive Payments – Enables users to receive funds from other users.
- Transaction History – Shows a record of previous financial transactions.
- Wallet Management – Allows users to manage their digital wallet and balances.
- Notifications – Provides alerts about completed transactions and system updates.
- Account Settings – Allows users to manage their profiles and security settings.

Admin Portal

The Admin Portal is designed for administrators to monitor and manage platform operations.

Key features include:

- Admin Dashboard – Displays system activity and transaction summaries.
- User Management – Allows administrators to manage registered users.
- Transaction Monitoring – Enables oversight of transactions across the platform.
- Reports and Analytics – Provides insights into system performance and usage.
- System Notifications – Allows admins to send announcements to users.
- Platform Settings – Enables configuration of system policies and settings.

Application Layer

The Application Layer handles the business logic and processes user requests from the frontend.

This layer is implemented using Typescript and Node.js, and it communicates with Firebase services to perform backend operations such as authentication, transaction processing, and notifications.

The application layer includes several modules:

Authentication and Authorization

Handles user registration, login, and secure access control using Firebase Authentication.

User Management

Manages user profiles, personal information, and account details stored in the database.

Wallet Management

Handles user wallet balances and updates balances during transactions.

Transaction Management

Processes financial transactions such as sending and receiving money while ensuring data consistency.

Notification Management

Sends real-time notifications to users about transaction updates and important system messages.

Payment Processing

Handles transaction validation and updates wallet balances after successful transfers.

Data Layer

The Data Layer manages data storage and retrieval within the PesaPath system.

The platform uses Firebase's cloud-based NoSQL database (Cloud Fire store) to store structured and semi-structured data related to users and transactions.

Cloud Fire store (NoSQL Database)

Cloud Fire store stores data in collections and documents rather than tables.

Data stored includes:

- User profiles
- Wallet balances
- Transaction records
- Payment history
- Notifications

Firebase Cloud Storage

Firebase Storage is used to store files such as:

- Transaction receipts
- Uploaded documents
- User profile images

All database operations are handled securely through Firebase services and application logic.

Component Breakdown Structure

Frontend Components

User Interface (UI)

The user interface provides access to the main system features through two portals:

User Portal

Features include:

- Dashboard
- Send Money
- Receive Payments
- Transaction History
- Wallet Management
- Notifications
- Settings

Admin Portal

Features include:

- Dashboard
- User Management
- Transaction Monitoring
- Reports and Analytics
- Notifications
- System Settings

Backend Components

- Authentication and Authorization (Firebase Authentication)

- User Management
- Wallet Management
- Transaction Management
- Notification Management
- Payment Processing

Infrastructure Components

- Firebase Authentication – Manages user login and identity verification
- Cloud Fire store (NoSQL Database) – Stores application data
- Firebase Cloud Storage – Stores files and user documents
- Firebase Cloud Messaging – Sends push notifications
- Google Cloud Platform – Provides hosting and infrastructure support

Technology Stack Components

- Typescript
- React Native
- Tailwind CSS
- Firebase
- Cloud Fire store (NoSQL Database)
- Firebase Authentication
- Firebase Cloud Storage
- Firebase Cloud Messaging
- Google Cloud Console

Figure 1: flow chart diagram

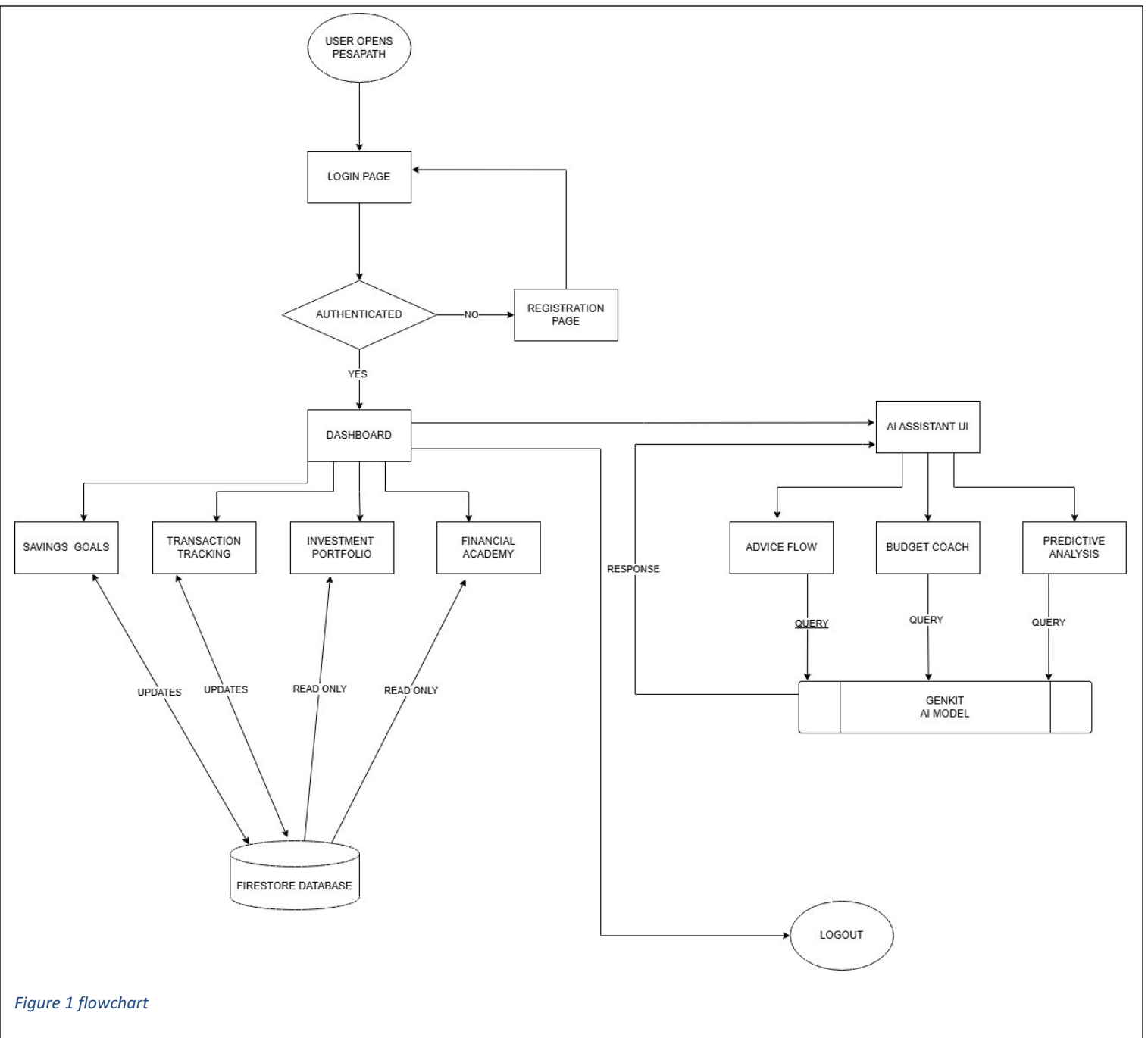


Figure 1 flowchart

Figure 2: Entity Relationship Diagram

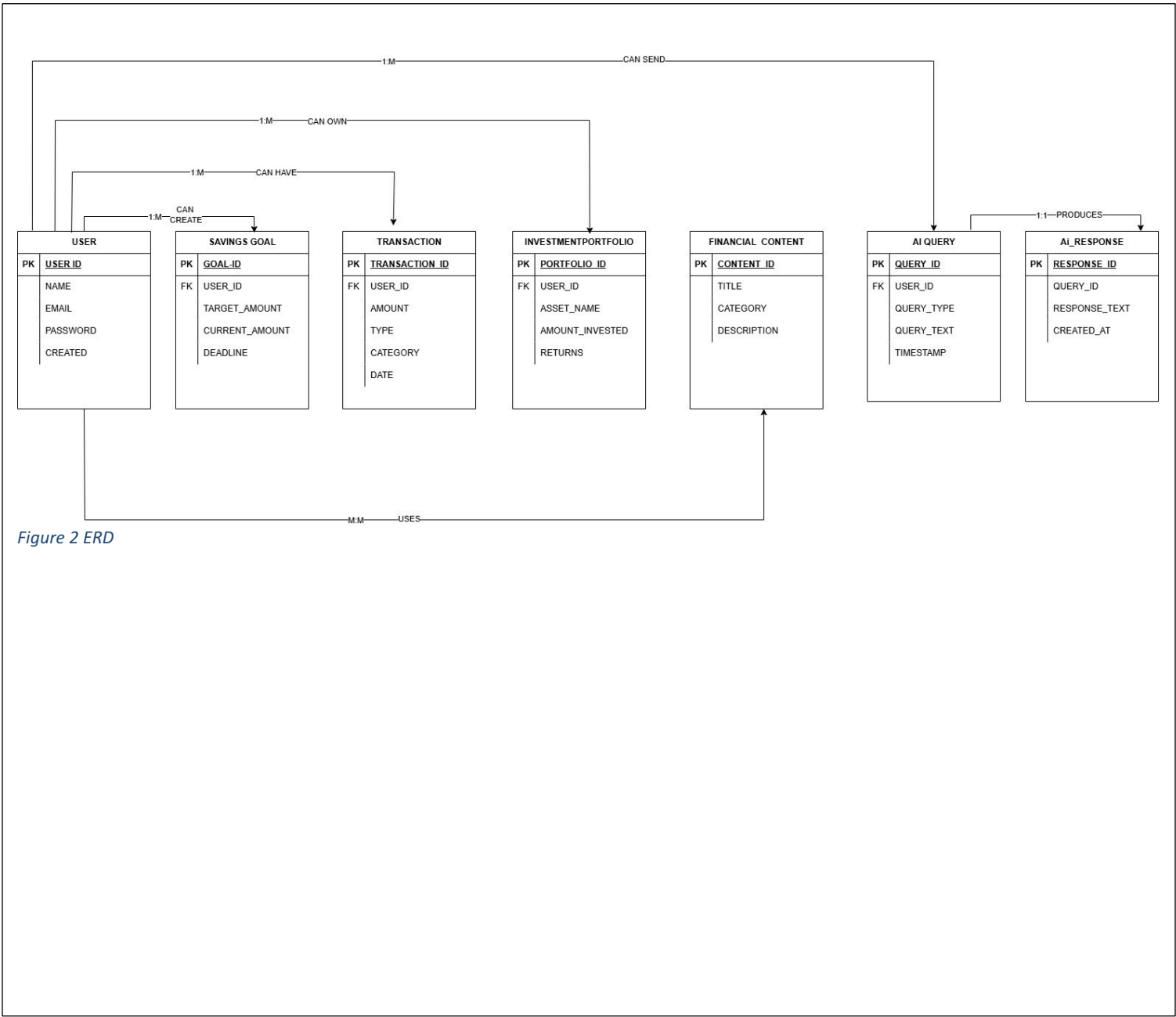


Figure 2 ERD

Research and Development Approach

The PesaPath project adopted an Agile development approach to ensure flexibility, iterative improvement, and continuous alignment with user needs. Agile methodology allowed the team to develop the system in **sprints**, enabling rapid implementation, testing, and refinement of features based on feedback from users and experts.

Requirement Gathering

The project began with a requirements-gathering phase, where the team collected and analyzed data from young adults in Kampala and at Uganda Christian University using questionnaires. This provided insights into their income patterns, spending habits, saving behaviors, and challenges in financial management. In addition, interviews with financial professionals from Equity Bank, UAP Insurance, and Postbank helped identify common financial challenges and informed the design of the AI-based financial advisory system.

System Design

Using the gathered data, the team created **wireframes, prototypes, and system architecture diagrams** to visualize the solution. These design artifacts guided the development of the **user interface, budgeting and expense tracking modules, AI-driven personalized financial guidance, and the financial learning platform.**

Iterative Development

The system was developed in **sprints**, each focused on specific features:

- Sprint 1: Implementation of budgeting and expense tracking tools
- Sprint 2: Integration of the AI-based financial chatbot
- Sprint 3: Design and development of the in-app financial academy
- Sprint 4: Gamification features, financial tips, and trust score system

Each sprint included development, testing, and user feedback collection. This iterative process ensured that features were refined continuously for usability, performance, and engagement.

System Development Tools

The platform was developed using:

- **Frontend and Mobile App:** Typescript, React Native, Next.js
- **Database and Storage:** Firebase and NoSQL
- **AI Integration:** Genk it with Google Gemini AI for personalized financial recommendations

Agile methodology allowed the team to prioritize critical features first, such as budgeting and expense tracking, while continuously improving additional functionalities like AI advice, gamification, and the financial learning platform.

Results / Achievements

The developed PesaPath system successfully achieved its objectives through the following features:

- **Budgeting and Expense Tracking:** The system includes an expense tracking dashboard and auto-saving functionality, enabling users to monitor income, control spending, and improve financial discipline. This directly addresses the objective of helping young people manage their finances effectively.
- **AI-Based Financial Advisor:** An AI-powered financial chatbot provides personalized advice, spending alerts, and savings predictions. This feature meets the objective of offering tailored financial guidance based on individual user behavior.
- **Financial Learning Platform:** The system incorporates an in-app financial academy that offers interactive lessons, quizzes, and reward-based learning, fulfilling the objective of improving users' financial literacy and investment knowledge.
- **Promoting Responsible Financial Behavior:** Gamified savings features, financial tips, and a **trust score system** encourage responsible financial habits and help users build long-term financial discipline, achieving the objective of promoting better financial behavior.
- **System Security and Reliability:** Strong user authentication and administrative controls ensure data protection, user privacy, and system reliability, supporting safe usage of the platform.

Overall, PesaPath demonstrates strong alignment between the project objectives, development methodology, and actual results. Users can now track expenses, manage income, receive AI-based personalized advice, access interactive financial education, and engage with gamified features that promote positive financial behavior. These achievements confirm that PesaPath provides a practical and effective solution for improving financial literacy and financial management among young people in Uganda.

Chapter Five: Implementation

5.1 Group Contributions to the Project Development Process

The development of the **PesaPath platform** was a collaborative effort involving all team members, each contributing their technical expertise to ensure the successful implementation of the system. The team worked together to design and develop a secure and scalable digital payment platform that allows users to send and receive money, manage digital wallets, and monitor financial transactions.

During the development process, the backend infrastructure of the system was implemented using **Firebase services**, which provided authentication, database management, and hosting capabilities. The team developed a cloud-based backend that enabled secure communication between the frontend interface and the database.

The backend services ensured that user requests such as **sending money, receiving payments, updating wallet balances, and retrieving transaction history** were processed efficiently and securely. Firebase Authentication was integrated to provide a secure login and registration system, while **Cloud Fire store**, a NoSQL database, was used to store user profiles, wallet balances, transaction records, and system notifications.

To ensure reliability and performance, the team implemented structured data models and optimized database queries to allow fast retrieval and processing of transaction data. Security was also prioritized throughout the development process to ensure that only authorized users could access sensitive financial information.

Through continuous testing, debugging, and refinement of system logic, the development team ensured that the PesaPath platform operates as a reliable, efficient, and secure digital payment system.

5.2 Collaboration and Communication

Effective collaboration and communication played an important role in the successful implementation of the PesaPath project.

Communication

For daily communication, discussions, idea sharing, and decision-making, the team used **Click Up**. This platform allowed team members to track tasks, share updates, and receive feedback from the instructor efficiently.

GitHub

GitHub was used for version control and collaborative development. The project repository was created to host the application code and manage contributions from different team members.

Team members used GitHub to:

- Create branches for different features
- Track issues and assigned tasks
- Monitor project progress
- Maintain a well-organized codebase

This ensured that the project code remained structured, maintainable, and easy for all team members to contribute to.

Regular Meetings

The team conducted regular physical and online meetings using Google Meet to discuss development progress, identify challenges, brainstorm solutions, and review feedback from the instructor. These meetings helped maintain clear communication and ensured that all team members remained aligned with the project objectives.

Team Presentations

To encourage participation and strengthen teamwork, each team member presented their assigned tasks and development progress to the rest of the group. Other members provided suggestions and feedback to improve the system. This process enhanced collaboration, knowledge sharing, and team confidence.

Responsibilities

The project team shared several responsibilities to ensure the successful completion of the PesaPath system.

Planning

The team developed a comprehensive project plan that outlined the system objectives, project milestones, timelines, and resource allocation. This planning helped ensure that development activities were organized and completed within the required timeframe.

Team Coordination

Tasks were distributed among team members according to their skills and assigned roles. Continuous coordination ensured effective collaboration and timely completion of development tasks.

Implementation of Feedback

Feedback from the instructor and users was carefully reviewed and incorporated into the system. This helped refine system requirements and improve the functionality and usability of the PesaPath platform.

Risk Management

Potential risks and obstacles that could affect project progress were identified early in the development process. Strategies were developed to mitigate these risks and ensure smooth project implementation.

Budget Considerations

The team ensured efficient use of available resources while maintaining the quality of the system during development.

5.4 Features Implemented

Several features were implemented during the development of the **PesaPath platform** to support digital financial transactions and improve user experience.

User Authentication System

Objective

To provide a secure system for user registration and login.

Implementation

Backend Setup (Firebase Authentication)

Firebase Authentication was integrated to manage user identity verification, registration, and login processes.

Frontend Implementation (React and Tailwind CSS)

User interfaces were developed to allow users to register, log in, and securely access their accounts.

Send Money Feature

Objective

Allow users to transfer money to other registered users on the platform.

Implementation

Database Structure (Cloud Fire store)

Fire store collections were created to store user wallet information and transaction data.

Transaction Logic

When a transaction occurs, the sender's wallet balance is deducted while the recipient's wallet balance is updated accordingly.

Frontend Interface

A simple form was implemented to allow users to input recipient details and transfer amounts.

Transaction History

Objective

Allow users to view records of their past financial transactions.

Implementation

Transaction data is stored in Fire store and retrieved through queries that display a list of transactions associated with the user account.

Wallet Management

Objective

Allow users to monitor their wallet balances and transaction activities.

Implementation

User wallet balances are stored and updated in Cloud Fire store, while the user dashboard displays current balances and recent activity.

Notifications

Objective

Provide users with alerts about completed transactions and system updates.

Implementation

Notifications were implemented using **Firebase Cloud Messaging**, which enables real-time alerts to users when important activities occur.

System Structure and Code Organization

To improve maintainability and collaboration, the project codebase was organized into structured folders such as:

- Components
- Pages
- Services/API
- Layouts
- Utilities

This structured approach allowed team members to easily locate and work on different system components.

GitHub repositories were also created to host the frontend and backend code and ensure proper version control throughout the development process.

5.5 Challenges Faced During Implementation and Solutions

During the implementation of the PesaPath platform, several challenges were encountered and addressed.

System Complexity

Managing multiple system features increased the complexity of the codebase. This challenge was addressed by organizing the system into smaller modules and reusable components to improve code clarity and maintainability.

Authentication and Security

Ensuring secure authentication for financial transactions required strong security mechanisms. This challenge was addressed by implementing **Firestore Authentication**, which provides secure user identity management.

NoSQL Database Design

Designing an efficient data structure in **Cloud Firestore** required careful planning. The database was structured using collections and documents to ensure efficient data retrieval and scalability.

Real-Time Data Synchronization

Ensuring that wallet balances and transactions updated instantly across the system was challenging. Firebase's real-time capabilities were used to synchronize data updates effectively.

Hosting Challenges

Deploying the application required a reliable hosting platform. Firebase Hosting and Google Cloud services were used to deploy and manage the application infrastructure.

5.6 Key Algorithms and Techniques Used in the Project

Several algorithms and techniques were used throughout the development of the PesaPath platform.

Authentication and Authorization

- Firebase Authentication for secure user login and identity management
- Role-based access control for system permissions

Data Fetching and Manipulation

- Filtering and sorting algorithms to organize transaction data
- Efficient Fire store queries for retrieving user information

Form Handling

- Input validation techniques to ensure correct user input
- Error handling mechanisms to provide clear feedback to users

Routing

- Client-side routing implemented using **React Router**
- Route protection to restrict access to authorized users

Error Handling

- Centralized error handling mechanisms
- User-friendly error messages displayed on the interface

Database Operations (NoSQL)

- Efficient document retrieval in Fire store
- Optimized queries to improve system performance

Real-Time Communication

- Real-time database updates using Firebase
- Push notifications using Firebase Cloud Messaging

Chapter six: Testing and Evaluation, Results and Discussions and conclusion

6.1 Testing Methodology

During the development of the **PesaPath platform**, a structured testing approach was adopted to ensure that the system functioned correctly, securely, and efficiently. The team implemented **unit testing and functional testing** to verify the reliability and performance of individual components within the system.

Unit testing was carried out to examine specific system components such as authentication functions, transaction processing logic, and database interactions. Each component was tested independently to confirm that it behaved as expected before being integrated with other parts of the system. This approach helped the development team detect and correct errors early in the development process.

Automated testing tools and testing frameworks were used to streamline the testing process and improve the efficiency of quality assurance activities. Through these tests, the team ensured that the core functionalities of the PesaPath platform, including **user authentication, wallet management, sending money, and retrieving transaction records**, operated correctly and reliably.

In addition to unit testing, **manual testing** was also conducted to verify the usability of the system from a user's perspective. Team members simulated real user interactions such as creating accounts, sending funds, and viewing transaction history to ensure that the system interface was intuitive and user-friendly.

6.2 Test Results

During the testing phase, several test cases were executed to evaluate the functionality and performance of the system. The results of these tests were documented, including the **test case descriptions, input data, expected results, and actual results**.

For example, tests were conducted to confirm that users could successfully register, log into the system, and access their accounts securely. Additional tests were performed to verify that when a user sends money to another user, the system correctly deducts the amount from the sender's wallet and updates the recipient's wallet balance.

The testing process also evaluated the system's ability to retrieve and display transaction history accurately from the database. These tests confirmed that transaction records were stored and retrieved correctly from **Cloud Fire store**.

Key testing metrics were also observed during this phase, including:

- System response time
- Error detection rate
- Functionality accuracy
- Data consistency

The results indicated that the majority of system functions operated as expected, and any errors identified during testing were corrected through debugging and code improvements.

6.3 Evaluation Against Requirements and Objectives

After the completion of system testing, an evaluation was conducted to determine whether the **PesaPath platform met the predefined project requirements and objectives**.

The evaluation involved comparing the actual system behavior with the functional requirements that were established during the project planning phase. This included verifying that the system was capable of supporting core features such as **user registration and authentication, digital wallet management, sending and receiving payments, and viewing transaction history**.

The results of the evaluation confirmed that the system successfully achieved its intended objectives. The platform demonstrated the ability to provide a **secure and efficient digital payment solution**, allowing users to perform financial transactions conveniently through the system.

Furthermore, the use of **Firebase services and a NoSQL database (Cloud Fire store)** ensured reliable data storage, real-time updates, and secure authentication mechanisms. These features contributed to the overall reliability and usability of the PesaPath platform.

The evaluation also identified areas that could be improved in future system versions, such as expanding payment integration options and enhancing system scalability. These observations provide a foundation for future system development and improvement.

Overall, the testing and evaluation process confirmed that the **PesaPath platform meets the major functional requirements and project objectives**, demonstrating its potential to support digital financial transactions effectively.

6.4 Results and Discussions

Presentation of the Project Outcomes

The implementation of the **PesaPath platform** produced several outcomes that aligned with the objectives defined during the project planning phase. The system successfully provided a **secure and efficient digital payment platform** that allows users to send and receive money, manage digital wallets, and monitor transaction activities.

Through the developed platform, users were able to **create accounts, log into the system securely, and perform financial transactions within the platform**. The integration of Firebase services enabled secure authentication and reliable data storage, ensuring that sensitive financial data such as user profiles, wallet balances, and transaction records were safely stored and managed.

One of the key outcomes of the project was the successful implementation of a **digital wallet system**, which allowed users to view their wallet balances and track their financial transactions in real time. This feature improved transparency and enabled users to maintain better control over their financial activities.

Additionally, the system provided a **transaction history feature**, which enabled users to review previous transactions and monitor their spending patterns. The platform also included notification functionality that alerts users when transactions are completed, ensuring that users are always informed about account activity.

The **user-friendly interface** developed using React and Tailwind CSS made it easy for users to navigate through the system and perform financial operations without difficulty. Overall, the project

resulted in a functional digital payment platform capable of supporting secure and efficient financial transactions.

Analysis of Results in Relation to Project Goals

The results of our PesaPath project were analyzed in relation to the initial goals and objectives of the system. The analysis indicated that the system successfully achieved most of the intended goals.

One of the primary goals of the project was to develop a **secure and reliable digital payment system** that allows users to send and receive money. This objective was successfully achieved through the implementation of wallet management and transaction processing features supported by Firebase services.

Another key objective was to provide a system capable of **secure user authentication and account management**. The integration of Firebase Authentication ensured that users could securely create accounts, log in, and access their financial information without compromising security.

The project also aimed to provide **real-time data updates and reliable data storage**. By utilizing Cloud Fire store, the platform was able to update wallet balances and transaction records instantly, improving the overall user experience.

Furthermore, the implementation of **notifications using Firebase Cloud Messaging** allowed users to receive real-time alerts whenever transactions were completed or important account activities occurred. This feature enhanced system transparency and improved user confidence in the platform.

Although the project achieved its major objectives, certain limitations such as limited integration with external financial services and reliance on cloud infrastructure were identified. These limitations provide opportunities for future system improvement.

Overall, the results demonstrate that the **PesaPath platform successfully meets its primary goal of providing a secure and efficient digital payment solution**.

Future Implementations of the Project

Although the PesaPath platform successfully achieved its core objectives, several enhancements can be implemented in the future to further improve the system.

Firstly, the system can be enhanced by **integrating mobile money and banking APIs** such as MTN Mobile Money or Airtel Money. This would allow users to perform real financial transactions between the platform and existing financial services.

Secondly, implementing **advanced fraud detection mechanisms using artificial intelligence or machine learning** could improve the security of financial transactions by identifying suspicious activities and preventing fraudulent behavior.

Thirdly, the system could be expanded to include **merchant payment services**, enabling businesses to receive payments from customers through the platform.

Another potential improvement would be the **development of a mobile application version of PesaPath**. A mobile application would increase accessibility and allow users to perform financial transactions conveniently using their smartphones.

Finally, additional features such as **transaction analytics, budgeting tools, and financial insights** could be introduced to help users better manage their finances and monitor spending patterns.

These future improvements would significantly enhance the capabilities, scalability, and usability of the PesaPath platform, enabling it to serve a wider range of users and financial services.

6.5 Conclusion

The PesaPath platform project successfully achieved its main objective of developing a secure and efficient digital payment system designed to simplify financial transactions for users. Throughout the development process, several key system features were successfully implemented, including user authentication, digital wallet management, transaction processing, transaction history tracking, and real-time notifications. These features enable users to easily manage their financial activities within a single digital platform.

The system was developed using modern and reliable technologies such as **React, Tailwind CSS, Firebase Authentication, and Cloud Fire store**. These technologies provided a strong foundation for building a responsive, scalable, and secure system. React and Tailwind CSS helped create a user-friendly and responsive interface, while Firebase services ensured secure user authentication, efficient data management, and real-time updates within the platform.

The implementation and testing phases demonstrated that the PesaPath platform functions effectively and meets its intended goals. Users are able to create accounts, manage their digital wallets, send and receive funds, and track their transaction history efficiently. In addition, the system provides real-time notifications that keep users informed about transaction updates and important system activities.

Overall, the PesaPath platform provides a reliable, secure, and user-friendly solution for managing digital financial transactions. The system has the potential to improve financial accessibility and simplify payment processes for individuals and small businesses. With further improvements and integration of additional financial services, the platform could be expanded to support a wider range of digital financial activities in the future

6.6 Reflection on the Project's Success in Meeting Objectives

Based on the results obtained during system testing and evaluation, the PesaPath platform successfully achieved its main project objectives. The platform demonstrated the ability to support secure digital transactions and efficient management of user accounts and wallet balances.

The system architecture, which utilizes Firebase cloud services and a NoSQL database, provided reliable backend support for handling financial data and user authentication. Additionally, the intuitive user interface made it easier for users to navigate the system and perform financial transactions without difficulty.

The project also followed best practices in software development, including structured system design, modular coding, testing, and version control. These practices contributed to the stability, scalability, and maintainability of the system.

Overall, the PesaPath platform demonstrates strong potential as a digital payment solution that can simplify financial transactions and improve accessibility to digital financial services.

Suggestions for Further Improvements or Future Work

Although the PesaPath platform successfully meets its core objectives, several improvements can be implemented in future versions of the system.

One potential improvement is the development of a mobile application version of the platform, which would increase accessibility and allow users to perform transactions conveniently using smartphones.

Another enhancement would be the integration of mobile money and banking services, such as MTN Mobile Money and Airtel Money. This would allow users to transfer funds between the platform and existing financial systems.

The system could also benefit from the implementation of advanced security mechanisms, such as fraud detection systems and multi-factor authentication, to further strengthen transaction security.

Additionally, the introduction of financial analytics and budgeting tools would help users track their spending habits and manage their finances more effectively.

Finally, continuous monitoring of system performance, user feedback collection, and periodic updates will be essential to ensure that the platform remains relevant, secure, and capable of adapting to the evolving digital financial landscape.

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6.8 Appendices

Appendices c; System Screens Mobile view (PesaPath)

Our Dashboard

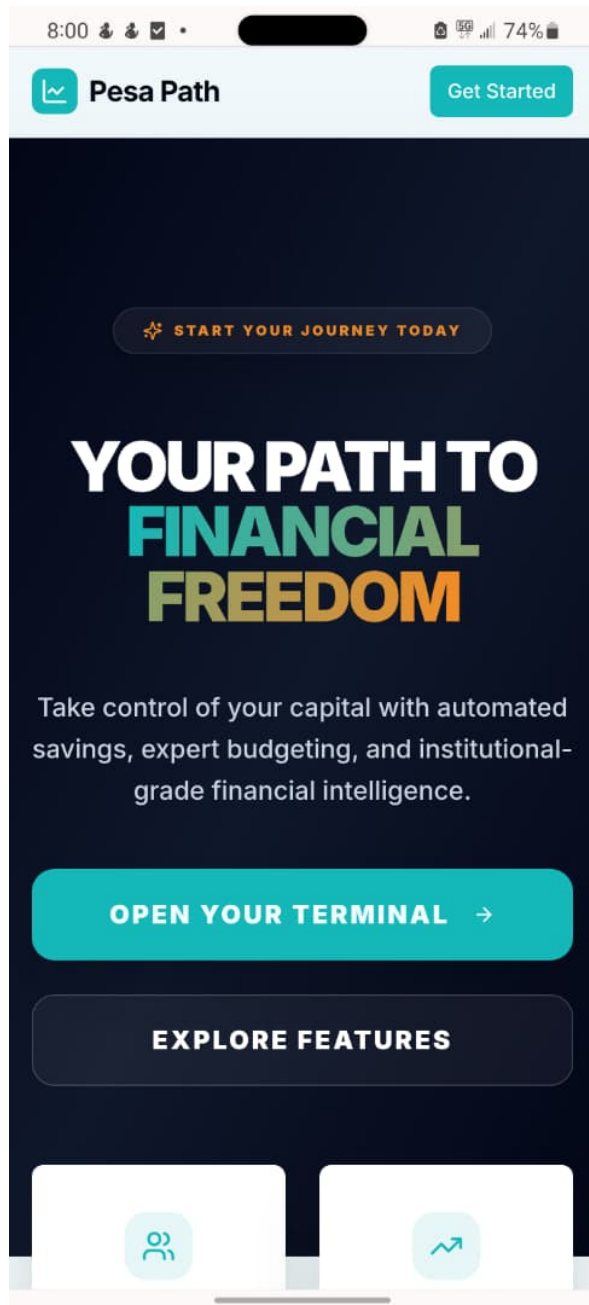


Figure 3 PESAPATH'S DASHBOARD

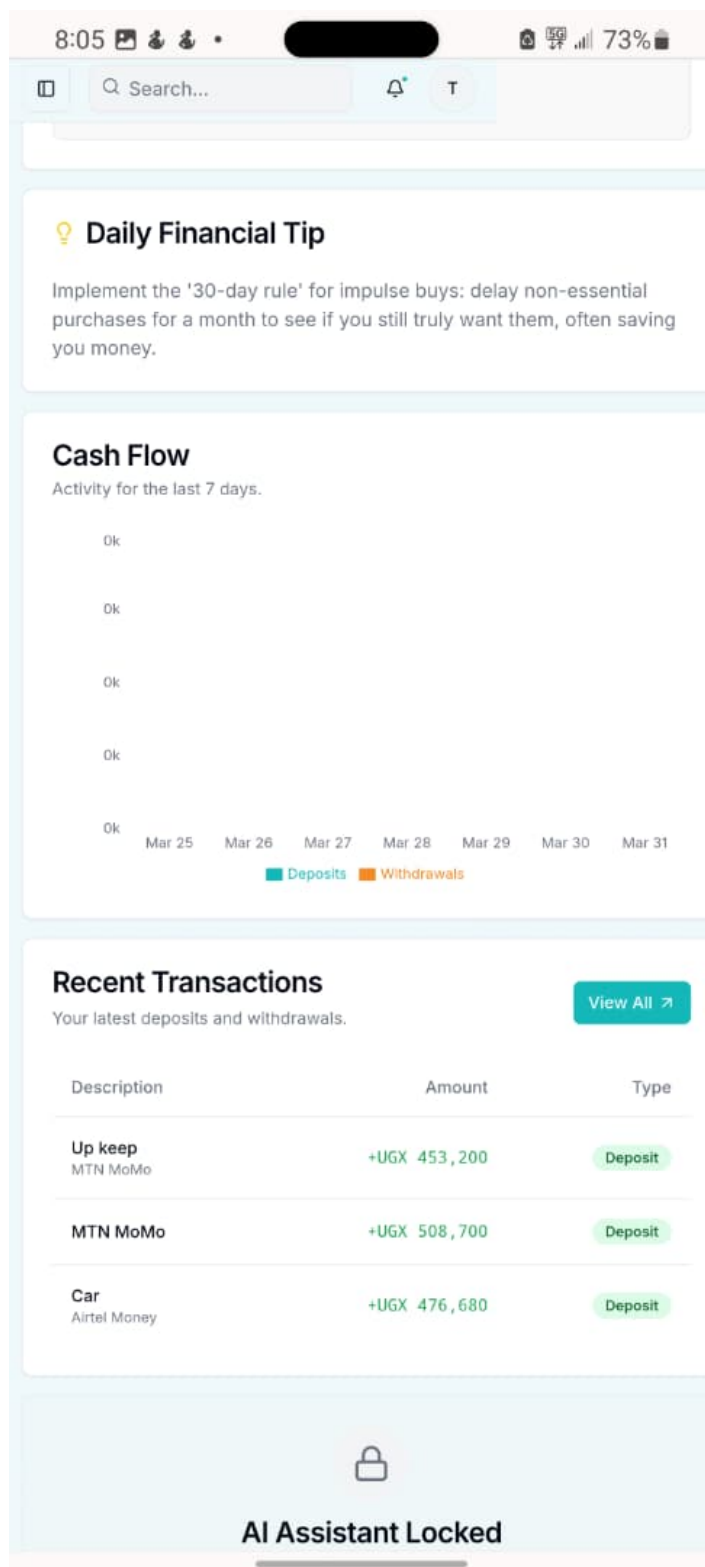


Figure 4 DISPLAY OF THE TRANSACTIONS AND TIPS

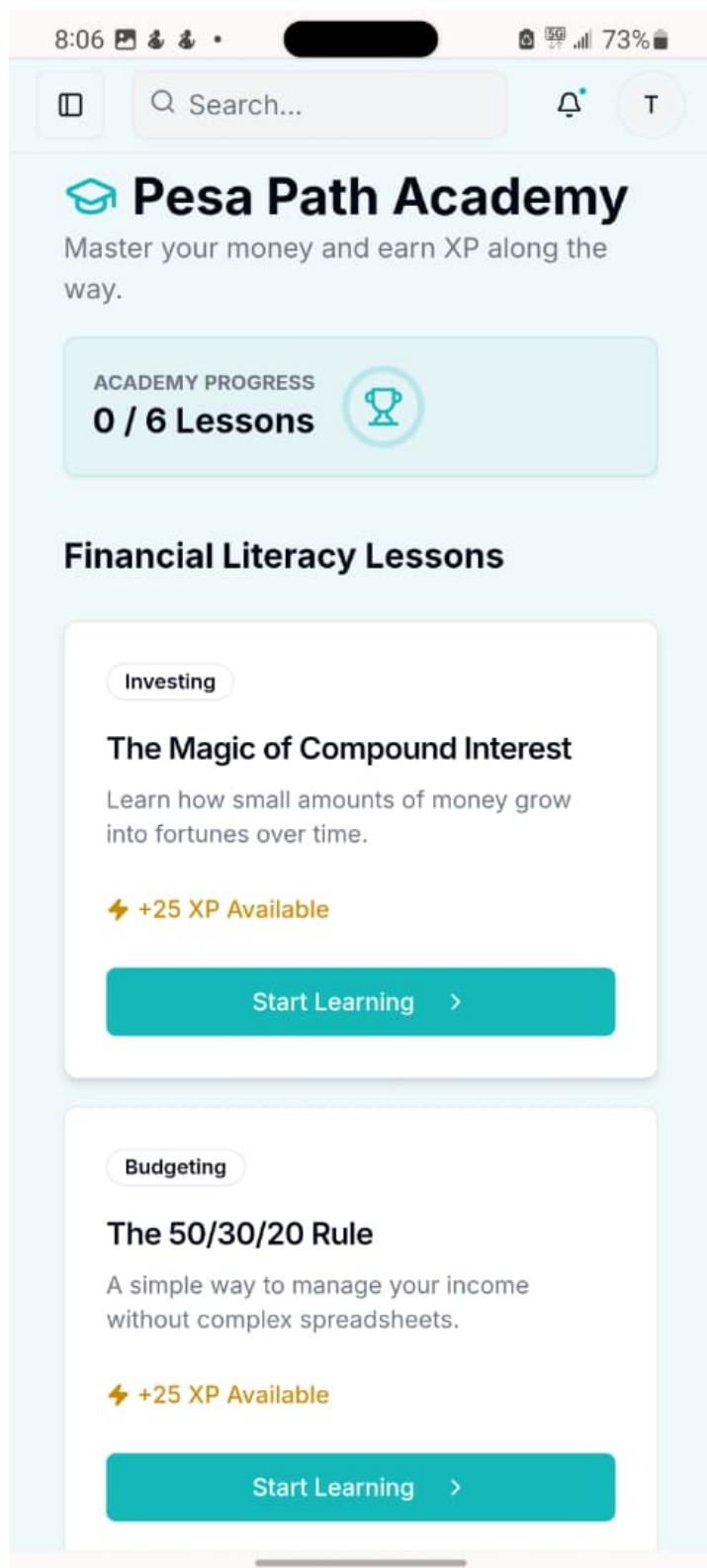


Figure 5 PESAPATH ACADEMY

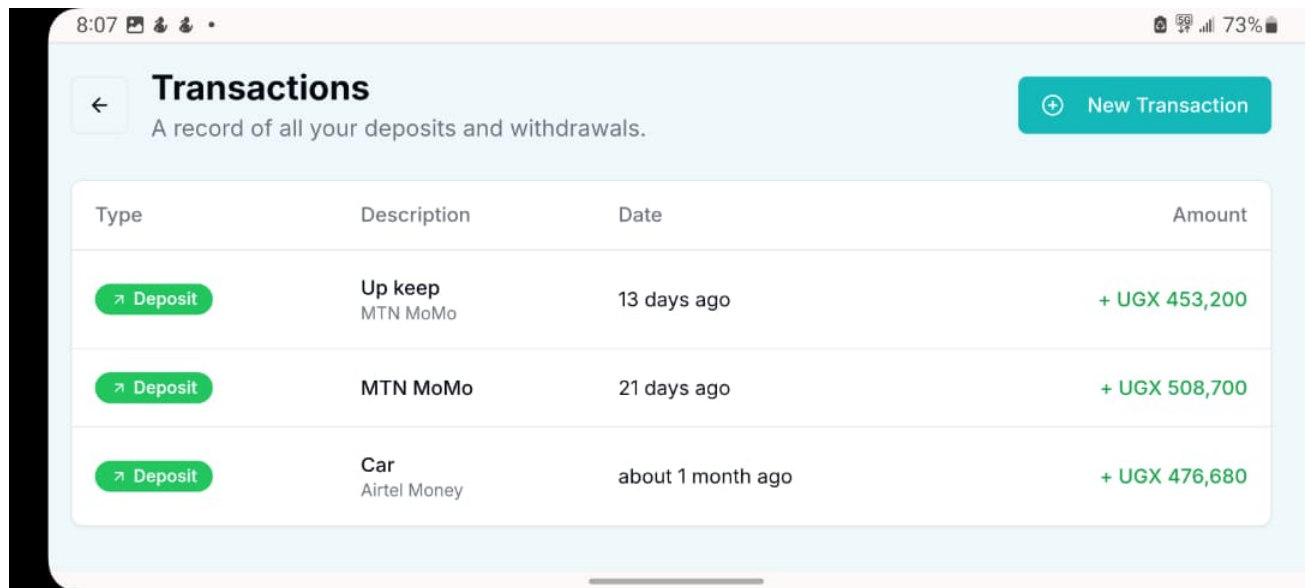


Figure 6 RECORDS FOR THE TRANSACTION