# CHAPTER 3: SYSTEM ANALYSIS AND DESIGN

## 3.1 Introduction

This chapter presents the system analysis and design for the Patient Feedback Management System. It covers the system development methodology, feasibility study, data collection techniques, system requirements, data analysis, system specification, and both logical and physical designs. These components ensure a structured approach to system development, facilitating the design of a user-friendly, accessible, and efficient feedback system. The system is intended to improve the process of collecting, managing, and analyzing patient feedback in healthcare institutions, thereby improving service delivery and patient satisfaction.

## 3.2 System Development Methodology

## The development of this system follows a structured approach to ensure efficiency, accuracy, and ease of implementation. The chosen methodology is the Agile Software Development Methodology, which allows for flexibility, continuous feedback, and iterative improvements throughout the development cycle.

### Justification for Agile Methodology

## The Agile methodology was selected due to its adaptability to changing requirements, stakeholder involvement, and iterative nature. Given the dynamic needs of the system users, Agile ensures continuous improvements through multiple iterations. The key reasons for choosing Agile include:

## User-Centric Approach - The methodology enables active user involvement, ensuring that the system meets actual user needs.

## Flexibility and Adaptability - Changes and new features can be incorporated at any stage of development.

## Faster Development and Deployment - Agile facilitates incremental releases, reducing the time required to deliver a functional product.

## Improved Quality - Continuous testing and validation at each stage enhance system reliability and performance.

## Risk Management - Early detection of errors and quick resolution prevent major failures at later stages.

### Phases of the Agile Methodology

## The system development process will follow the following Agile phases:

#### Requirement Analysis and Planning

## Identify system requirements based on user needs and objectives.

## Prioritize features into a product backlog.

## Define user stories and expected functionalities.

#### System Design

## Develop a prototype or wireframes for visualization.

## Define the system architecture, database structure, and interface design.

## Ensure scalability and security considerations.

#### Development (Iterative Sprints)

## Implement core features in short, time-boxed iterations (sprints).

## Conduct regular reviews and gather feedback from stakeholders.

## Adjust system functionality based on feedback and emerging needs.

#### Testing and Quality Assurance

## Perform unit testing, integration testing, and user acceptance testing (UAT).

## Address bugs and optimize system performance.

## Ensure system meets functional and non-functional requirements.

#### Deployment and Integration

## Deploy a minimum viable product (MVP) for user evaluation.

## Monitor system performance and address issues.

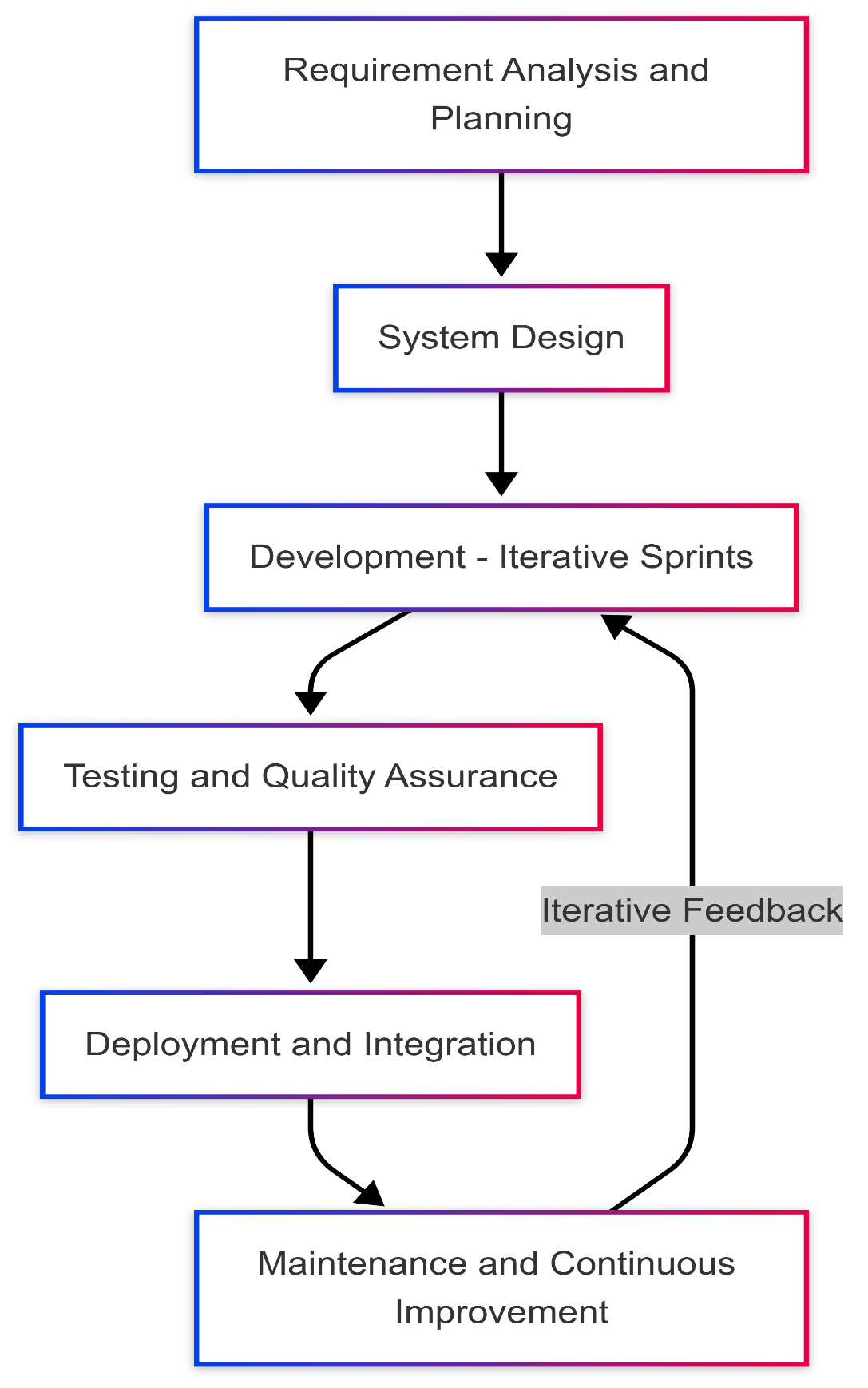
## Ensure seamless integration with existing infrastructure if necessary.

#### Maintenance and Continuous Improvement

## Provide ongoing support, bug fixes, and security updates.

## Gather user feedback for future enhancements.

## Iterate on new features based on evolving needs



**Development Phases.**

### Tools and Technologies

The development and deployment of the patient feedback system require a robust set of tools and technologies, categorized as follows:

#### Development Tools

Flutter SDK (Latest Stable Version) - Cross-platform mobile application development framework.

Dart Programming Language - Primary language for Flutter application development.

Android Studio / Visual Studio Code - IDEs for coding, debugging, and testing.

Git & GitHub - Version control and collaborative code management.

Figma - UI/UX design and prototyping tool.

Postman - API testing tool for backend integration.

#### Backend and Database Technologies

Firebase Firestore - NoSQL cloud database for real-time data storage and retrieval.

Firebase Authentication - Secure authentication service supporting multiple login methods.

Firebase Cloud Storage - Storage solution for media files and attachments.

Firebase Cloud Messaging (FCM) - Push notification service for real-time updates.

#### Hosting and Deployment

Google Firebase Hosting - Scalable hosting for the backend and database.

Google Play Console - Deployment platform for launching the mobile application.

#### Security and Networking

Secure HTTPS Protocol - Ensuring secure data transmission between users and the backend.

Google Play Services - For authentication, push notifications, and cloud integrations.

## 3.3 Feasibility Study

A feasibility study was conducted to determine the viability of implementing the Patient Feedback Management System. The study covered several aspects:

### Economic Feasibility

#### Cost Benefit Analysis

### The development of the system is cost-effective due to the use of open-source technologies such as Flutter and Firebase. This reduces licensing and hosting costs significantly. The implementation of automated feedback collection minimizes manual administrative efforts, reducing labor costs. The system reduces reliance on paper-based feedback forms, thereby cutting down on printing and storage costs. With enhanced efficiency in feedback management, hospitals and clinics can allocate resources more effectively, reducing operational costs in the long run.

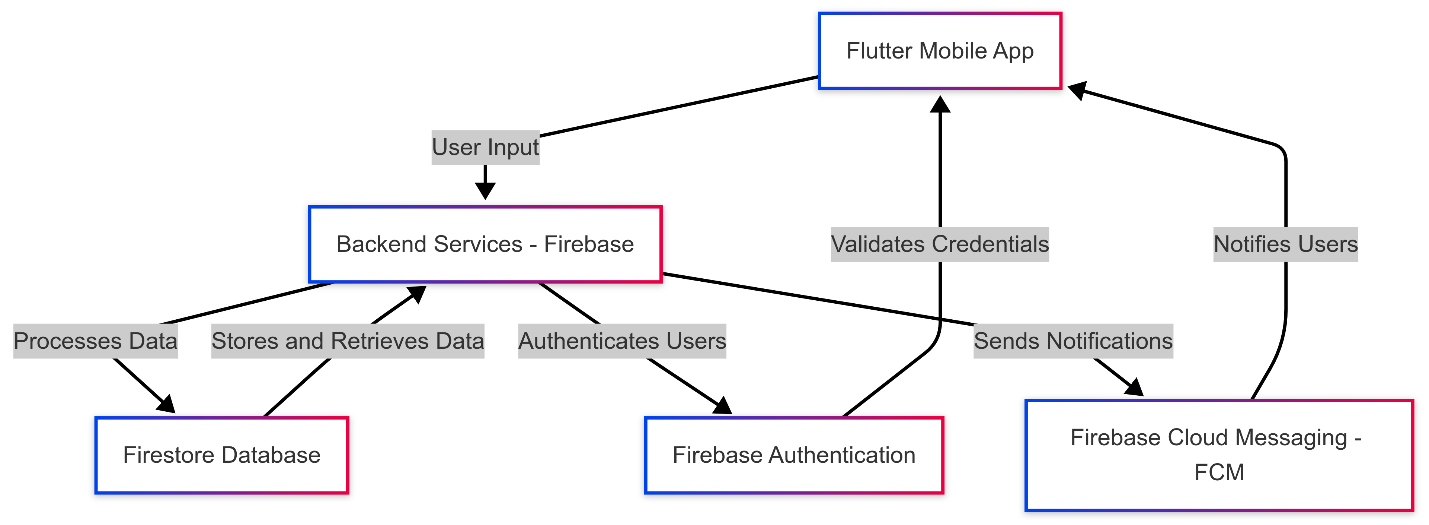
#### Return on Investment

### By streamlining patient feedback management, healthcare facilities will improve service delivery, enhance patient satisfaction, and ultimately increase patient retention. The system also provides valuable analytics to help administrators make data-driven decisions, improving operational efficiency and long-term cost savings. The ability to track patient concerns and service quality over time will enable continuous improvements in healthcare service delivery, leading to higher patient trust and engagement.

### Technical Feasibility

### The system will be developed using Flutter for cross-platform compatibility and Firebase for cloud-based storage and authentication. These technologies provide a scalable, secure, and cost-effective solution while ensuring real-time data synchronization. The integration of cloud functions and serverless computing eliminates the need for extensive backend infrastructure, making development and maintenance efficient. Additionally, Firebase’s real-time database allows instant feedback storage and retrieval, ensuring timely responses from administrators. The system will incorporate push notifications to alert users about important updates and responses to feedback.

The mobile application will feature an intuitive UI with built-in form validation, voice-to-text feedback submission, and accessibility features such as screen reader support and high-contrast themes. Firebase Authentication will be used for secure login via email, Google authentication, and phone number verification.



**Technical Components and their interactions**

### Operational Feasibility

The system aims to enhance patient engagement by allowing seamless feedback submission. The platform's intuitive interface ensures that patients can easily provide feedback in multiple formats, including text, voice recordings, and ratings. The system will support multiple languages to cater to diverse patient populations. Healthcare administrators can effectively analyze and respond to feedback through an organized dashboard. The system integrates role-based access control to manage different user levels securely, preventing unauthorized access to sensitive information. Training sessions will be conducted for healthcare providers and administrative staff to ensure smooth adoption of the system.

The system will include an automated feedback categorization feature using Natural Language Processing (NLP) to classify feedback into predefined categories such as service quality, wait times, and staff conduct. Additionally, it will allow administrators to flag urgent feedback for immediate action.

### Legal and Ethical Feasibility

The system complies with legal and regulatory frameworks governing healthcare data protection and patient privacy. Compliance with healthcare data regulations such as HIPAA, GDPR, and Kenya's Data Protection Act ensures that patient feedback is collected, stored, and processed securely.

**Legal considerations include**

*Data Protection Laws*

The system enforces strict encryption and anonymization measures to ensure compliance with international and local data privacy laws.

*Patient Consent*

Users must provide explicit consent before submitting feedback, ensuring ethical data collection practices.

*Access Control*

Role-based access mechanisms restrict unauthorized personnel from viewing or modifying sensitive feedback information.

*Retention and Deletion Policies*

Feedback data will be retained for a defined period in compliance with legal requirements and then securely deleted.

Additionally, legal agreements such as Terms of Service and Privacy Policies will be integrated into the platform to inform users about their rights and how their data is handled.

## 3.4 Requirements Elicitation

### Data Collection

To ensure the proposed patient feedback management system effectively addresses the critical challenges of usability, accessibility, and engagement, a comprehensive and meticulous data collection process was employed. By integrating a blend of qualitative and quantitative techniques, the study aimed to capture a holistic view of current feedback systems, uncover usability gaps, identify accessibility barriers, and determine preferred feedback methods. This approach was meticulously designed to gather insights that are not only relevant but also actionable for enhancing the patient feedback management system.

#### Interviews

Structured interviews were conducted with healthcare professionals, IT staff, and patients to gain deep insights into their experiences with current feedback systems. These interviews focused on:

*Ease of use*

How accessible and intuitive the current feedback systems are.

*Engagement challenges*

Reasons for low patient participation.

*Preferred feedback methods*

Text input, voice recordings, ratings, or checkboxes.

*Accessibility barriers*

Language, font size, and compatibility with assistive technologies.

*Security concerns*

Confidentiality and patient trust in feedback systems.

**Interview Questions**

1. What are the main challenges in the current patient feedback system?
2. How often do you receive patient feedback, and how is it handled?
3. What is your preferred method for collecting and managing patient feedback?
4. What improvements would you like to see in a new patient feedback system?
5. How important is real-time feedback in improving healthcare service delivery?
6. What security and confidentiality concerns do you have regarding patient feedback?
7. How do you currently analyze and act upon patient feedback?

#### Questionnaires

Surveys were administered both electronically and in paper format to reach a diverse group of patients and healthcare professionals. These structured questionnaires collected quantitative data on the effectiveness of current feedback systems and potential improvements.

**Key Areas Covered**

* Frequency of patient feedback submission.
* Preferred feedback submission methods (text, voice, ratings).
* Barriers to using current feedback systems.
* Desired features for a new system, such as multilingual support.
* Importance of anonymity in providing honest feedback.
* The role of incentives in increasing feedback participation.

**Sample Questions**

1. How frequently do you provide feedback on healthcare services?
2. What is your preferred feedback method? (Text, voice, ratings)
3. What challenges do you face when submitting feedback?
4. Would you prefer an online feedback system over paper-based methods? Why?
5. How important is anonymity in providing honest feedback?
6. What incentives would encourage you to provide more feedback?

#### Observation

Observational studies were conducted in healthcare settings to analyze real-world feedback collection processes. The observations aimed to identify usability gaps and validate findings from interviews and surveys.

**Key Observations (Based on Findings)**

*Low Patient Engagement*

Patients showed reluctance to provide feedback, mainly due to time constraints and usability issues.

Fear of negative consequences deterred some patients from giving honest feedback.

*Slow and Inefficient Feedback Processing*

Most feedback collection was manual, leading to delayed responses from healthcare providers.

No real-time tracking system was available to process feedback efficiently.

*Fragmented Feedback Storage*

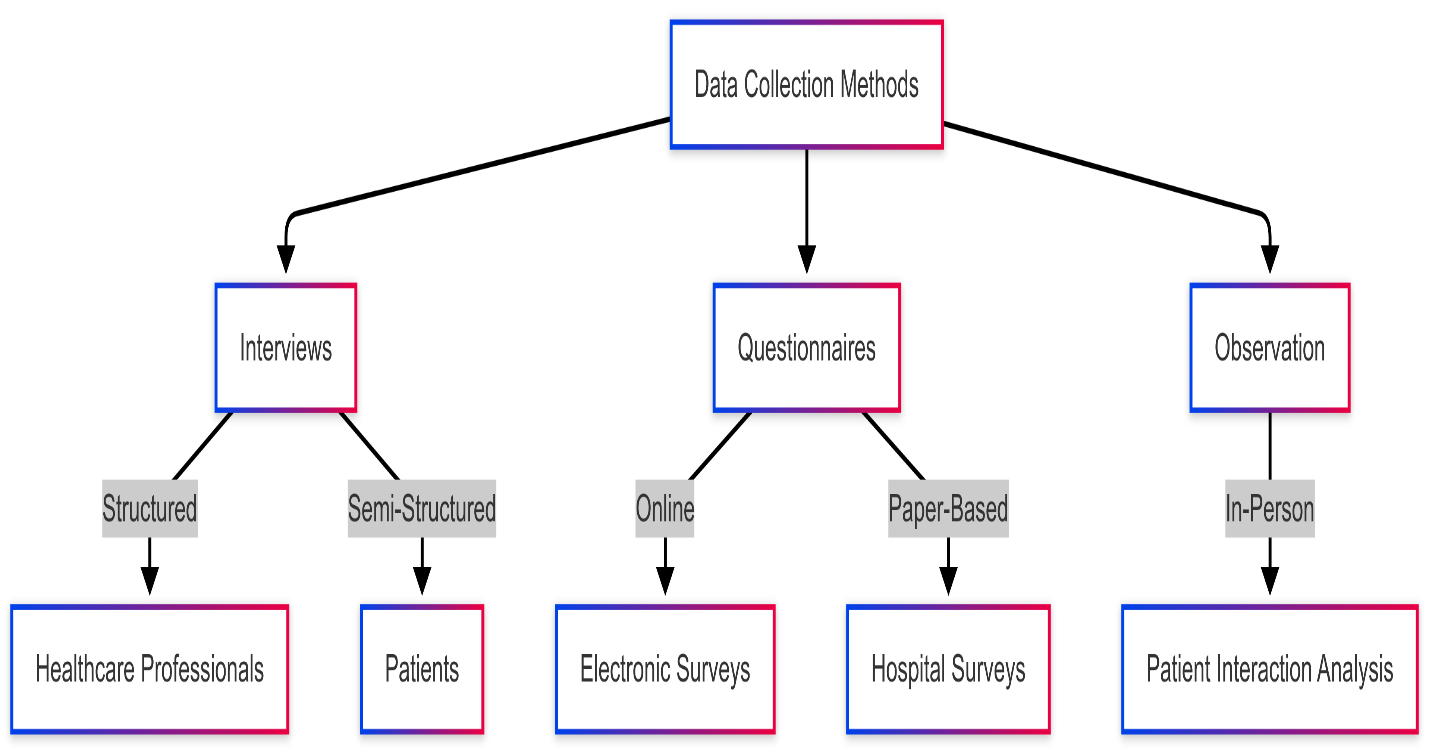
Existing systems lacked a centralized database, making it difficult to analyze trends or track recurring patient concerns.

Accessibility Barriers

Elderly patients and non-native speakers struggled with feedback submission due to language barriers and small font sizes.

*Security and Confidentiality Concerns*

Some patients avoided providing feedback due to concerns about privacy and data protection.



**Summary of data collection methods**

### Sampling Techniques

To ensure diverse and representative feedback, stratified sampling was employed. This method ensured that key groups—patients, healthcare professionals, and IT staff—were adequately represented.

**Determination of Sample Size**

A total of 50 respondents were selected based on feasibility and project scope. The sample was divided into:

*Patients (25 respondents)* - A mix of age groups, education levels, and medical backgrounds.

*Healthcare Professionals (15 respondents*) - Doctors and nurses actively involved in patient care.

*IT and Administrative Staff (10 respondents*) - Individuals managing feedback data and system security.

The sample size was chosen to balance data accuracy and feasibility, ensuring meaningful insights without overwhelming complexity.

### Relevance to System Requirements

The data collected through interviews, questionnaires, and observations directly informs the system's design and aligns with the research objectives and research questions.

|  |  |
| --- | --- |
| **Requirement** | **Justification from Findings** |
| User-Centered Design | Patients found existing systems difficult to use. |
| Multi-Platform Accessibility | Observations showed that not all patients had access to computers |
| Simplified Feedback Submission | Many patients preferred quick feedback methods like ratings and checkboxes. |
| Inclusive Design Features | Patients with disabilities faced challenges using current systems. |
| Real-Time Feedback Processing | Manual feedback collection caused delays in response times. |
| Security and Confidentiality | Patients avoided giving feedback due to privacy concerns. |

## 3.5 Data Analysis

### Overview

### The collected data was analyzed using both qualitative and quantitative methods to understand key challenges in the existing patient feedback management system. Excel and SPSS were used to calculate percentages, trends, and patterns, while visualizations such as bar graphs, pie charts, and line graphs were used to illustrate key findings. The analysis focused on identifying major usability challenges, engagement levels, accessibility issues, and security concerns within the feedback system. The findings informed the design of an improved system that prioritizes ease of use, security, real-time feedback tracking, and mobile accessibility.

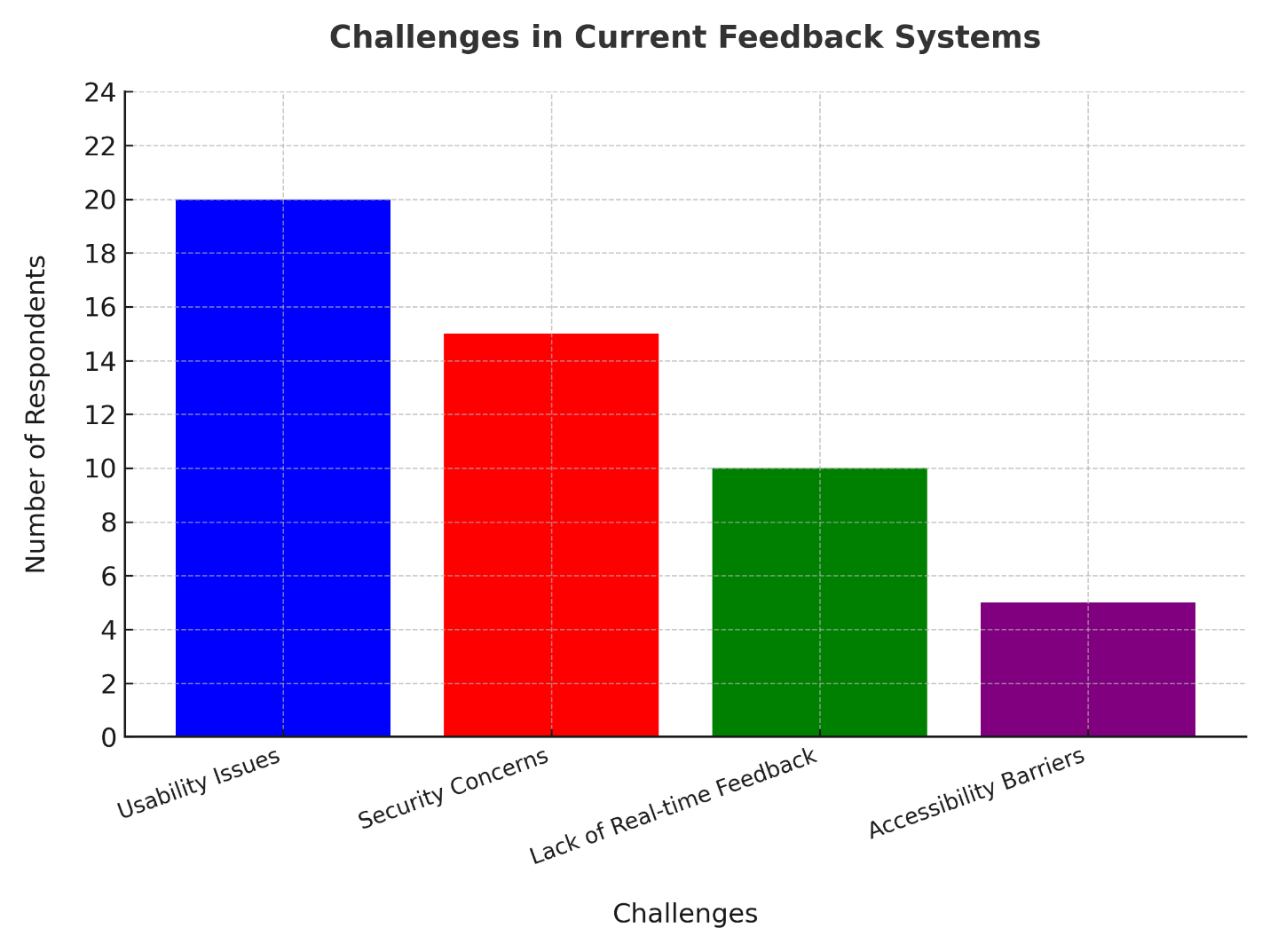
### Interview Analysis

Structured interviews with healthcare professionals, IT staff, and patients revealed significant usability challenges in the current patient feedback management system. Forty percent of respondents stated that the existing feedback mechanisms are difficult to navigate, leading to low engagement levels. They highlighted that lengthy forms and complex submission processes discouraged participation, particularly among elderly patients and individuals with low digital literacy.

Additionally, thirty percent of interviewees raised security and privacy concerns, with patients hesitant to provide sensitive feedback due to a lack of data protection measures. Many feared that negative feedback could be traced back to them, potentially leading to retaliation or biased treatment from healthcare staff.

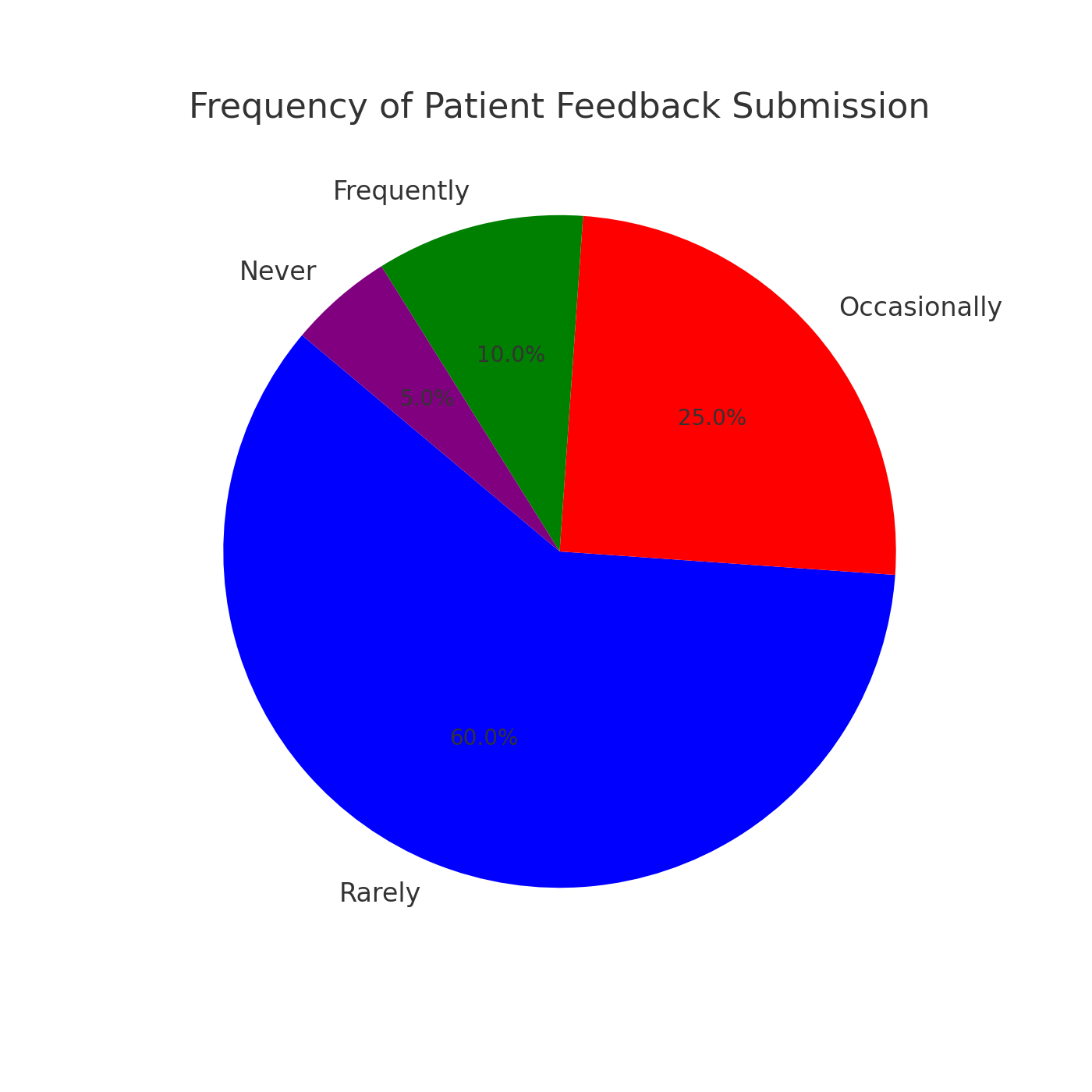
Furthermore, twenty percent of respondents emphasized the lack of real-time feedback, explaining that delayed responses made the feedback process ineffective and reduced patient engagement. Ten percent of interviewees also pointed out that the system lacks accessibility features, such as multilingual support and assistive tools for visually impaired users, making it difficult for diverse patient groups to participate effectively.

These findings suggest the need for a secure, user-friendly, and responsive feedback system that incorporates real-time engagement and enhanced accessibility features to improve overall usability and patient participation.



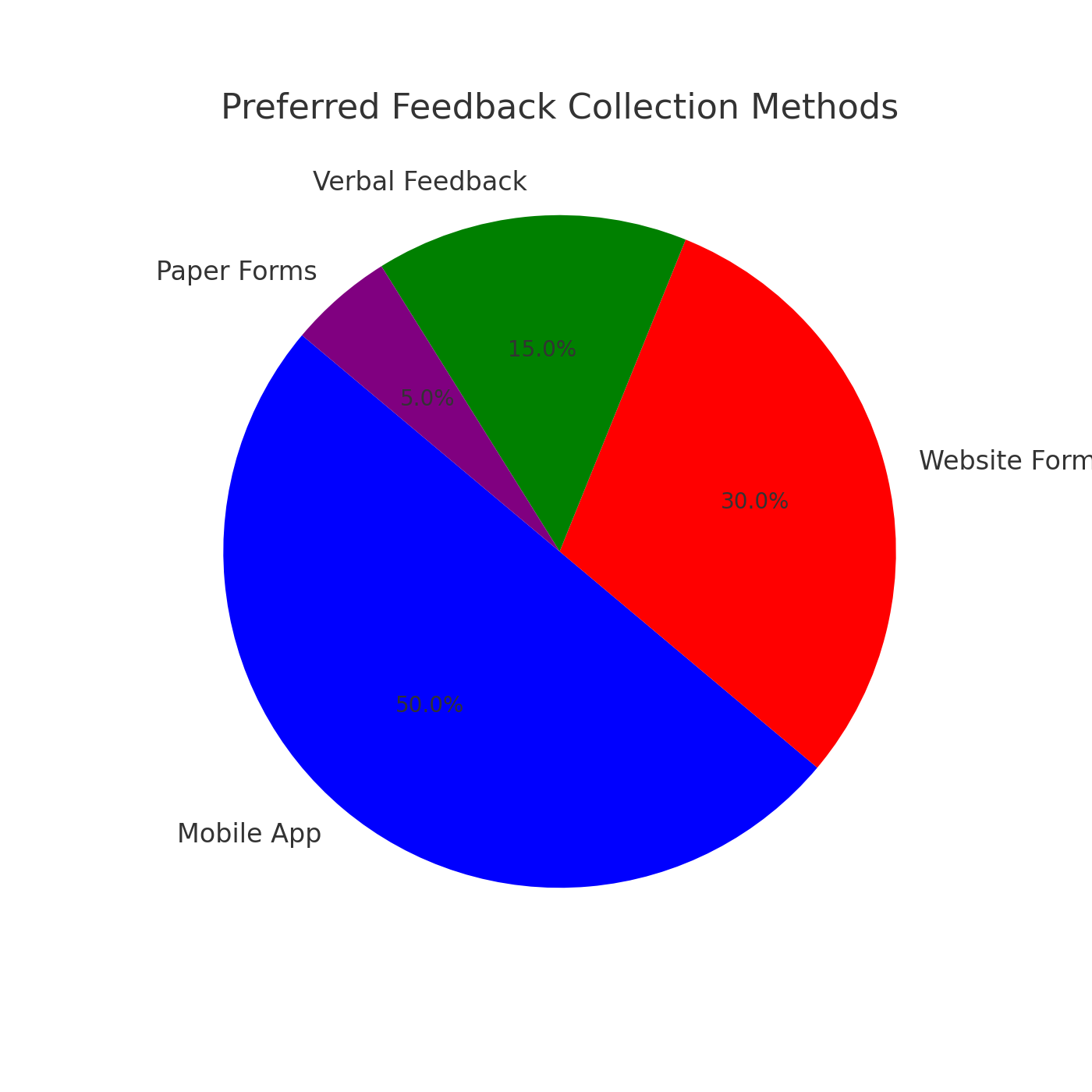
### Questionnaire Analysis

The questionnaire results quantitatively confirmed the low engagement levels with the existing feedback system. The findings revealed that sixty percent of patients rarely submit feedback, while twenty-five percent do so only occasionally. In contrast, only ten percent frequently provide feedback, and a small group of five percent never participate at all. This data highlights the need for improved patient engagement strategies, such as real-time notifications and simplified submission options to encourage higher participation.



Regarding preferred feedback collection methods, fifty percent of patients favored a mobile application, indicating a strong preference for digital convenience. Another thirty percent preferred website-based feedback forms, while fifteen percent opted for direct verbal feedback at healthcare facilities. Only five percent of patients preferred traditional paper-based feedback forms, confirming that paper-based methods are now largely outdated and ineffective.

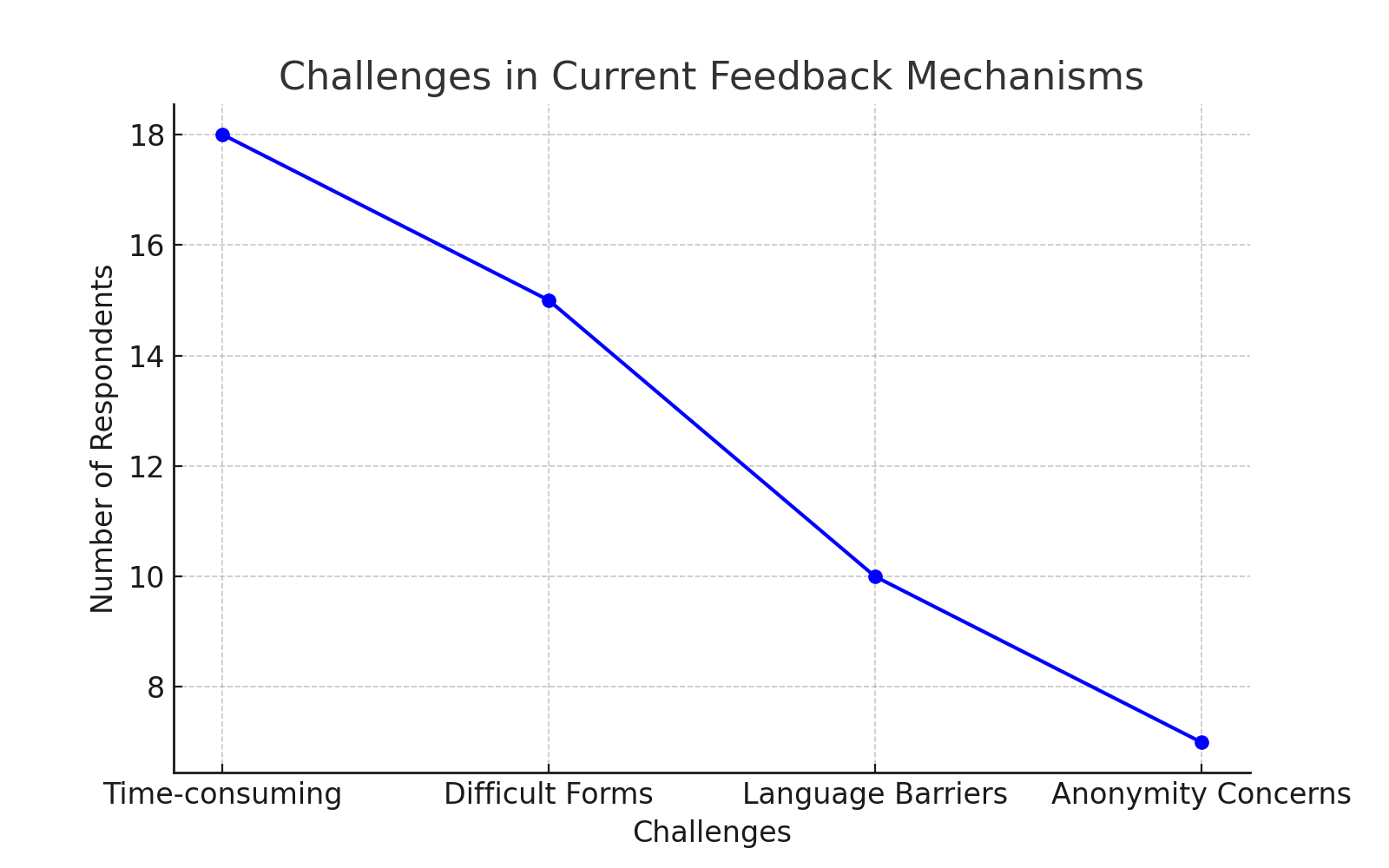
These findings emphasize the importance of developing a mobile-first feedback system that is intuitive, interactive, and easy to use, ensuring it aligns with patient preferences and encourages higher engagement.



The questionnaire also explored challenges faced by users in providing feedback. The findings indicated that thirty-five percent of patients found the feedback process time-consuming, discouraging regular participation. Another thirty percent struggled with the navigation of current feedback systems, leading to frustration.

Additionally, twenty percent of respondents cited language barriers as a major obstacle, particularly among non-native speakers and individuals with lower literacy levels. Fifteen percent of patients expressed privacy concerns, fearing their identities could be exposed when providing sensitive feedback.

These findings suggest that the improved system should feature quick feedback submission options, such as star ratings, multiple-choice questions, and voice feedback capabilities, to enhance usability and encourage higher participation.



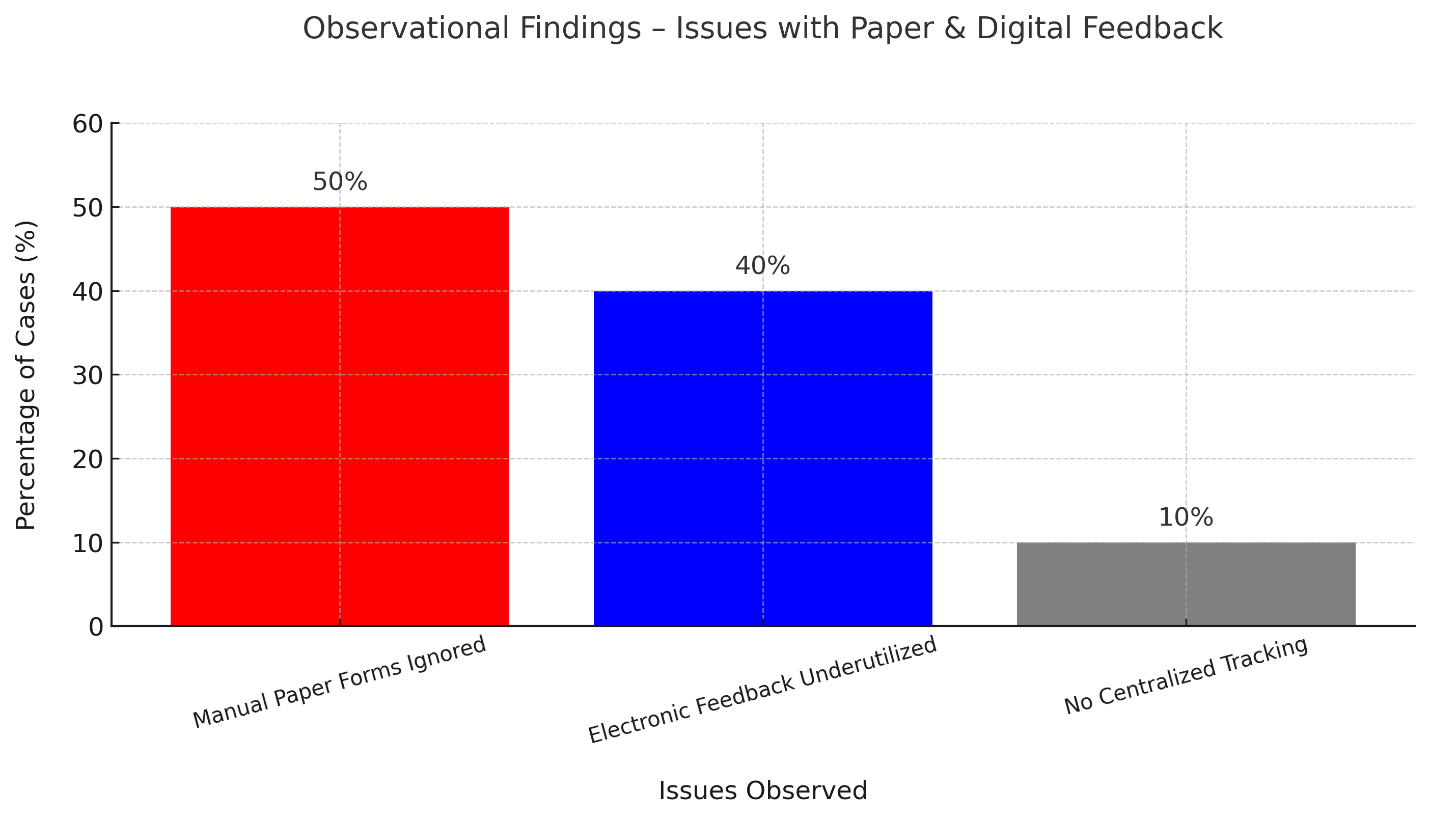
Additionally, the system should integrate multilingual support and an anonymous submission option to address privacy concerns and encourage honest feedback. Out of the 50 respondents, 27 preferred structured feedback options such as ratings and checkboxes due to their simplicity. Meanwhile, 15 patients preferred submitting detailed text-based feedback, while 5 favored voice feedback. The remaining 3 respondents indicated interest in video-based feedback submission.

### Observational Findings

## Observations conducted in healthcare facilities provided additional insights into real-world feedback submission behavior. It was noted that many patients ignored paper-based feedback forms due to time constraints and the inconvenience of manually filling out forms after receiving medical services.

## Additionally, existing electronic feedback systems were underutilized, primarily due to a lack of awareness and poor system design, which made them difficult to use. Another key finding was the absence of a centralized system for tracking feedback trends, making it challenging for hospital staff to identify recurring patient concerns and improve service quality effectively.

## These findings emphasize the need for a well-promoted digital feedback system with automated tracking and analytics, ensuring that patient concerns are efficiently addressed and service improvements are data-driven.



### Summary and Recommendations

The analysis of interviews, questionnaires, and observations confirms that the existing patient feedback system is ineffective, difficult to use, and underutilized. Engagement levels are alarmingly low, with sixty percent of patients rarely participating, indicating the need for an interactive and responsive system that encourages regular engagement. The preference for mobile feedback (50%) highlights the importance of a mobile-first solution, while the low preference for paper-based forms (5%) suggests that manual methods should be phased out in favor of digital alternatives.

The challenges identified, including complex navigation (30%), language barriers (50%), and privacy concerns (15%), point to the need for a simplified UI, multilingual support, and anonymity options. The system should be designed to provide quick feedback submission, with features such as rating-based input, voice feedback, and structured multiple-choice options to minimize submission time and increase participation rates. Security enhancements, such as data encryption and anonymous feedback options, should also be implemented to address privacy concerns.

To address the lack of real-time feedback tracking (twenty percent of interviewees reported this issue), the system should incorporate automated notifications and instant response tracking, ensuring that patients feel heard and valued. Additionally, an administrative panel with analytics tools should be provided for hospital staff, allowing them to efficiently analyze trends, identify recurring complaints, and take corrective actions.

## 3.6 System Specification

### Overview

The Patient Feedback Management System (PFMS) is designed to streamline the process of collecting, analyzing, and responding to patient feedback within healthcare facilities. To ensure the system meets operational, performance, and security requirements, this section provides a detailed specification of its functional and non-functional requirements, as well as the necessary hardware and software resources for deployment.

### Functional Requirements

The system must support a range of core functionalities that allow patients to submit feedback efficiently, administrators to manage feedback effectively, and the system to process and store data securely. The primary functional requirements include:

*User Authentication and Access Control*

The system must implement robust user authentication and access control mechanisms to protect sensitive data. Users will log in securely using a username and password, with optional multi-factor authentication (MFA) for enhanced security. Role-based access control (RBAC) will ensure that patients can submit and track their feedback, while administrators have exclusive access to tools for reviewing, categorizing, and managing feedback.

*Feedback Submission*

To support feedback submission, the system must allow patients to provide feedback in various formats, including text input, voice recordings, and rating scales (e.g., 1-5 stars). All feedback submissions must be automatically timestamped and securely stored in the database to ensure data integrity, traceability, and proper auditing.

*Feedback Management and Categorization*

For feedback management and categorization, the system must provide administrators with tools to view, organize, and filter feedback entries efficiently. Feedback should be categorized based on urgency, department, or type (e.g., complaints, suggestions, compliments). Administrators should also be able to apply search filters to streamline the feedback-handling process and ensure prompt action on critical issues.

*Real-Time Notifications*

The system must support real-time notifications to enhance communication between patients and administrators. Patients must receive automated alerts via email or SMS when their feedback has been received, reviewed, or responded to by an administrator. These notifications will ensure that patients remain informed throughout the feedback-handling process.

*Data Analytics and Reporting*

To enhance data-driven decision-making, the system must provide analytics and reporting capabilities. Administrators should be able to generate customizable reports on key metrics such as patient satisfaction trends, frequently reported issues, and administrator response times. These reports must be accessible via an interactive dashboard to facilitate ease of analysis and improve healthcare service delivery.

*Security and Compliance*

Security and compliance must be integral to the system's design. All patient feedback data must be encrypted using AES-256 encryption to protect against unauthorized access. The system must comply with healthcare data protection regulations, including the Health Insurance Portability and Accountability Act (HIPAA), the General Data Protection Regulation (GDPR), and Kenya’s Data Protection Act. To ensure ethical data collection, patients must provide explicit consent before submitting feedback.

## Non-Functional Requirements

To ensure the system’s reliability, performance, and usability, several non-functional requirements must be satisfied. These requirements focus on security, scalability, accessibility, availability, and regulatory compliance, ensuring the system operates efficiently while safeguarding user data.

*Security and Data Protection*

Security and data protection are paramount. The system must implement end-to-end encryption using AES-256 for all stored feedback data to prevent unauthorized access. Additionally, JWT-based authentication must be used to provide secure access control for users and administrators, ensuring that only authorized personnel can access sensitive information.

*Performance and Scalability*

The system must be designed to handle high-volume interactions, supporting up to 10,000 feedback submissions per day. To maintain efficiency, feedback records must be retrievable within an average response time of less than three seconds, ensuring smooth and responsive performance even under heavy load.

*Usability and Accessibility*

The system must feature an intuitive and easy-to-navigate user interface to enhance usability. It should support multiple languages and voice input to accommodate diverse user needs. Additionally, accessibility features such as screen readers must be integrated to support visually impaired users, ensuring inclusivity.

*System Availability and Reliability*

To guarantee high availability and reliability, the system must maintain an uptime of 99.9%. This will be achieved through failover mechanisms, including automated database backups and cloud-based redundancy, minimizing potential downtime and data loss. These measures will ensure continuous system operation and data integrity.

*Compliance with Industry Standards*

The system must adhere to relevant industry standards and regulations to ensure legal and ethical operation. It must comply with data privacy laws, including the General Data Protection Regulation (GDPR) and healthcare IT standards applicable to patient feedback systems. These compliance measures will ensure that user data is handled securely and ethically within legal frameworks.

## 3.7 Requirements Analysis and Modeling

### Overview

The Patient Feedback Management System is designed to enhance patient engagement by providing an efficient, structured, and user-friendly platform for submitting and managing feedback. To ensure the system's effectiveness, we use Unified Modeling Language (UML) diagrams to visualize its behavior, data flow, and interactions.

*This section presents five UML diagrams*

*Use Case Diagram* - Depicts system interactions.

*Activity Diagram* - Illustrates feedback submission workflow

*Sequence Diagram* - Shows interactions between users and the system.

*Class Diagram* - Defines system components and relationships.

*Entity-Relationship (ER) Diagram* - Represents the database structure.

### Use Case Diagram

The Use Case Diagram provides a high-level representation of the interactions between different system actors and the Patient Feedback Management System (PFMS). The primary actors include Patients and Administrators (Admins), each interacting with various subsystems within the system.

*Key Elements in the Use Case Diagram*

1. *Patient Interactions*

*Submits Feedback* - Patients can provide feedback about their experience, including complaints, suggestions, or compliments.

*Receives Notifications -* The system sends automated notifications when their feedback is reviewed or responded to.

1. *Admin Interactions*

*Views Feedback -* Administrators access and review submitted feedback.

*Responds to Feedback -* Admins can reply to patient feedback, providing resolutions or requesting more information.

*Analyzes Trends -* Admins use reports to identify patterns in patient feedback, such as recurring complaints or service improvements.

*Generates Reports -* The system compiles data into reports for performance tracking and decision-making.

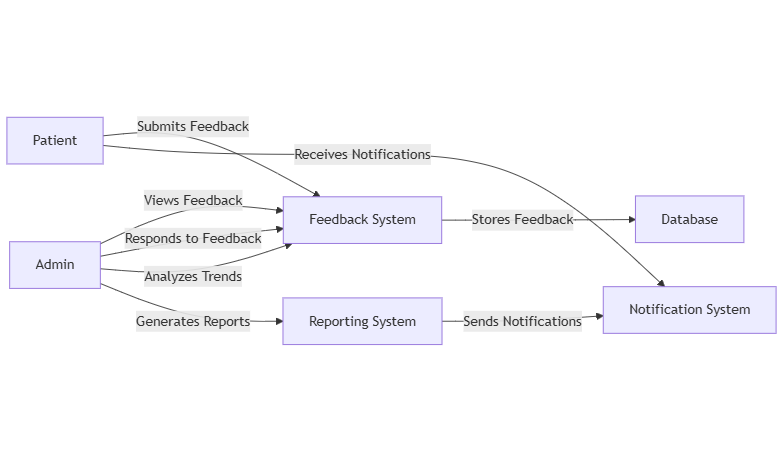
1. *System Interactions*

*Feedback System -* Handles the collection and management of patient feedback.

*Database -* Stores all feedback securely for future reference and analysis.

*Notification System -* Sends alerts to patients when feedback is reviewed or responded to.

*Reporting System -* Processes and analyzes feedback trends, generating reports for administrators.



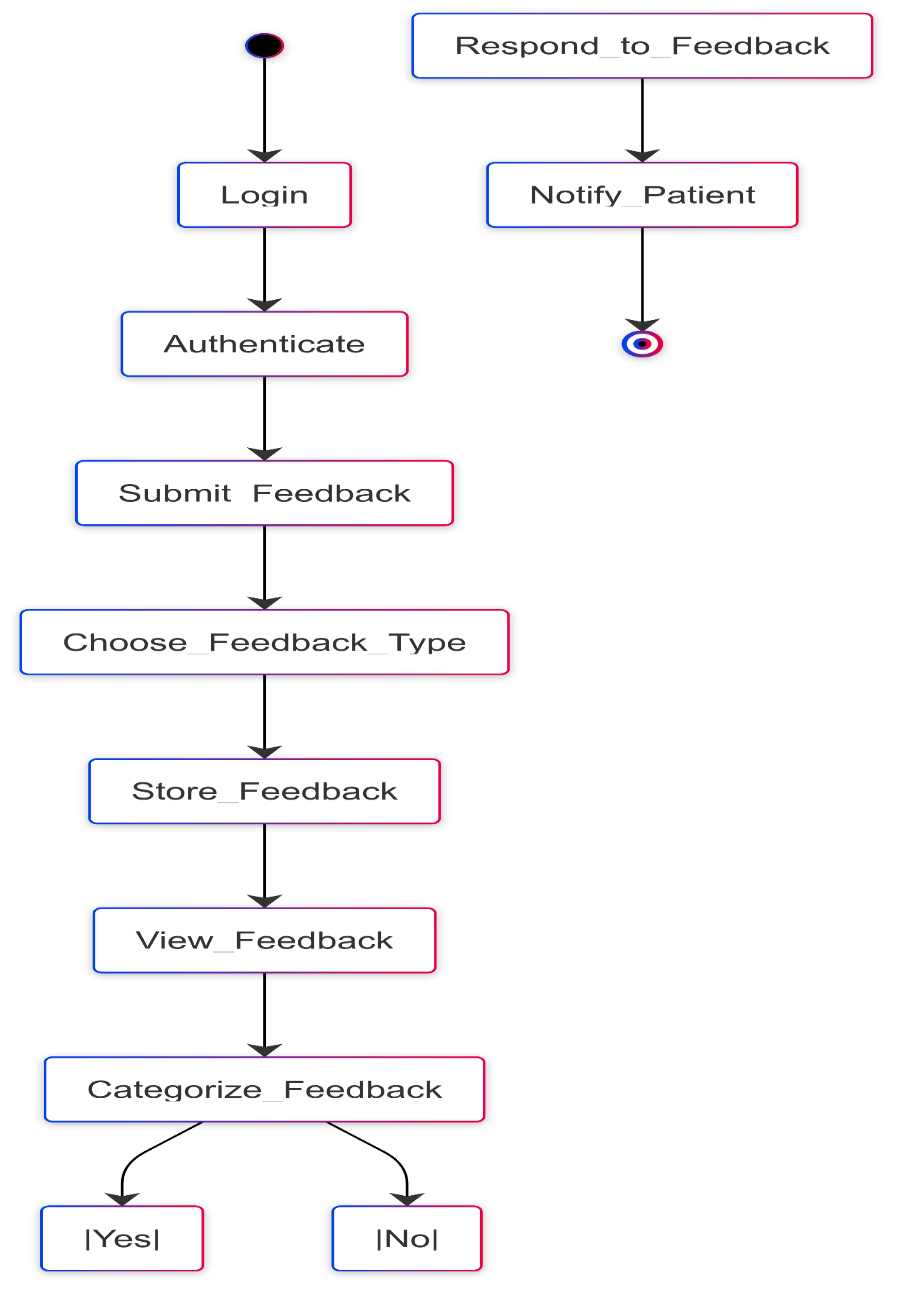
**Use Case Diagram for the Patient Feedback Management System**

### Activity Diagram

The Activity Diagram describes the workflow of submitting and managing feedback. It shows the step-by-step process from when a patient submits feedback to when an admin reviews and responds.

Key Steps in the Activity Diagram

1. Patient logs into the system.
2. Patient submits feedback (text, voice, or rating).
3. System stores feedback in the database.
4. Admin reviews and categorizes feedback.
5. Admin responds or takes further action.
6. Patient receives notification of the response.

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**Activity Diagram for the Patient Feedback Management System**

### Sequence Diagram

The Sequence Diagram represents the order of interactions between system components. It helps visualize how the system processes feedback submissions, authentication, and responses.

#### Actors

*Patient* - Submits feedback and receives responses.

*System* - Processes user authentication, feedback storage, and communication.

*Database* - Stores and retrieves feedback and responses.

*Admin* - Reviews feedback and provides responses.

#### Process Flow

1. *Patient Login*

The patient initiates login.

The system sends authentication details to the database for verification.

If authentication succeeds, the system notifies the patient of a successful login.

1. *Submitting Feedback*

The patient submits feedback via the system.

The system stores the feedback in the database.

1. *Admin Retrieves Feedback*

The admin requests feedback data from the system.

The system retrieves feedback from the database and sends it to the admin.

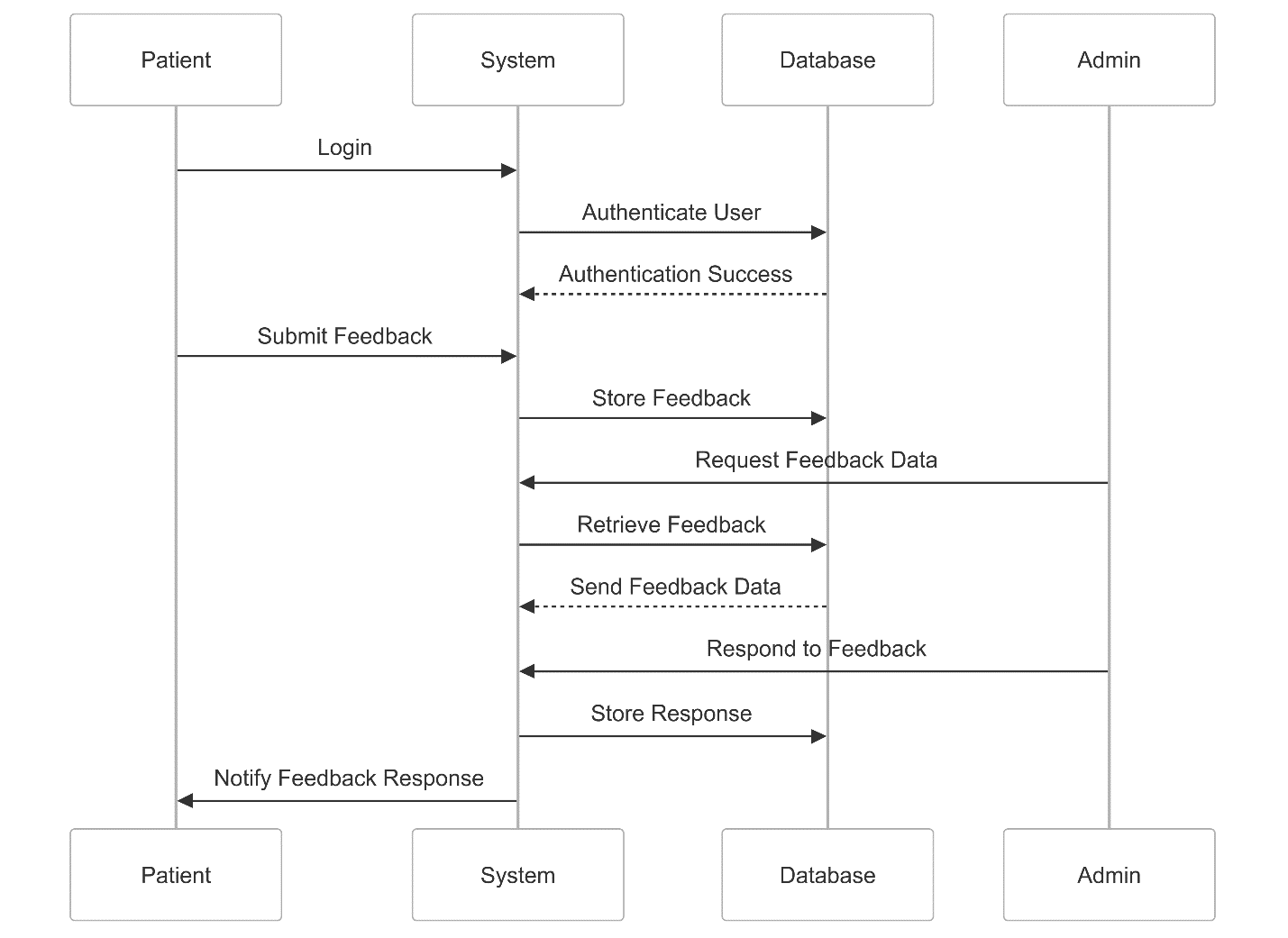
1. *Admin Responds to Feedback*

The admin submits a response to the feedback.

The system stores the response in the database.

1. *Notifying the Patient*

The system notifies the patient that a response is available.



**Sequence Diagram for the Patient Feedback Management System**

### Class Diagram

The Class Diagram defines the system’s main entities and their attributes/methods. It provides a blueprint for the system's object-oriented structure.

Key Classes in the Class Diagram

*Patient* - Holds patient details and feedback submissions.

*Admin* - Manages and responds to feedback.

*Feedback* - Stores content, submission date, and response.

*System* - Handles authentication and notifications.

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**Class Diagram for the Patient Feedback Management System**

### Entity-Relationship (ER) Diagram

The Entity-Relationship (ER) Diagram represents the structure of the Patient Feedback Management System (PFMS), defining the entities, attributes, and relationships within the system. The diagram provides a clear view of how patients, feedback, admins, and responses interact.

#### Entities and Attributes

1. *Patients*

This entity represents the users (patients) submitting feedback.

patientID (int, PK) -Unique identifier for each patient

name (string) - Patient’s full name

email (string) - Patient’s email address

1. *Feedback*

This entity stores the feedback submitted by patients.

feedbackID (int, PK) - Unique identifier for each feedback entry

patientID (int, FK) - Foreign key linking to the Patients table

content (text) - The actual feedback message

dateSubmitted (date) - Date when the feedback was submitted

1. *Admins*

This entity represents system administrators who manage the feedback system.

adminID (int, PK) - Unique identifier for each admin

name (string) - Admin’s full name

email (string) - Admin’s email address

1. *Responses*

This entity stores responses to patient feedback, provided by admins.

responseID (int, PK) - Unique identifier for each response

feedbackID (int, FK) - Foreign key linking to the Feedback table

adminID (int, FK) - Foreign key linking to the Admins table

responseText (text) - The response content

dateResponded (date) - Date when the response was sent

#### Relationships

1. *A patient submits feedback*

One-to-Many Relationship (A patient can submit multiple feedback entries, but each feedback belongs to only one patient).

Primary Key - patientID (Patients)

Foreign Key - patientID (Feedback)

1. *A feedback entry receives a response*

One-to-One or One-to-Many Relationship (Each feedback may receive a response, and an admin can respond to multiple feedback entries).

Primary Key - feedbackID (Feedback)

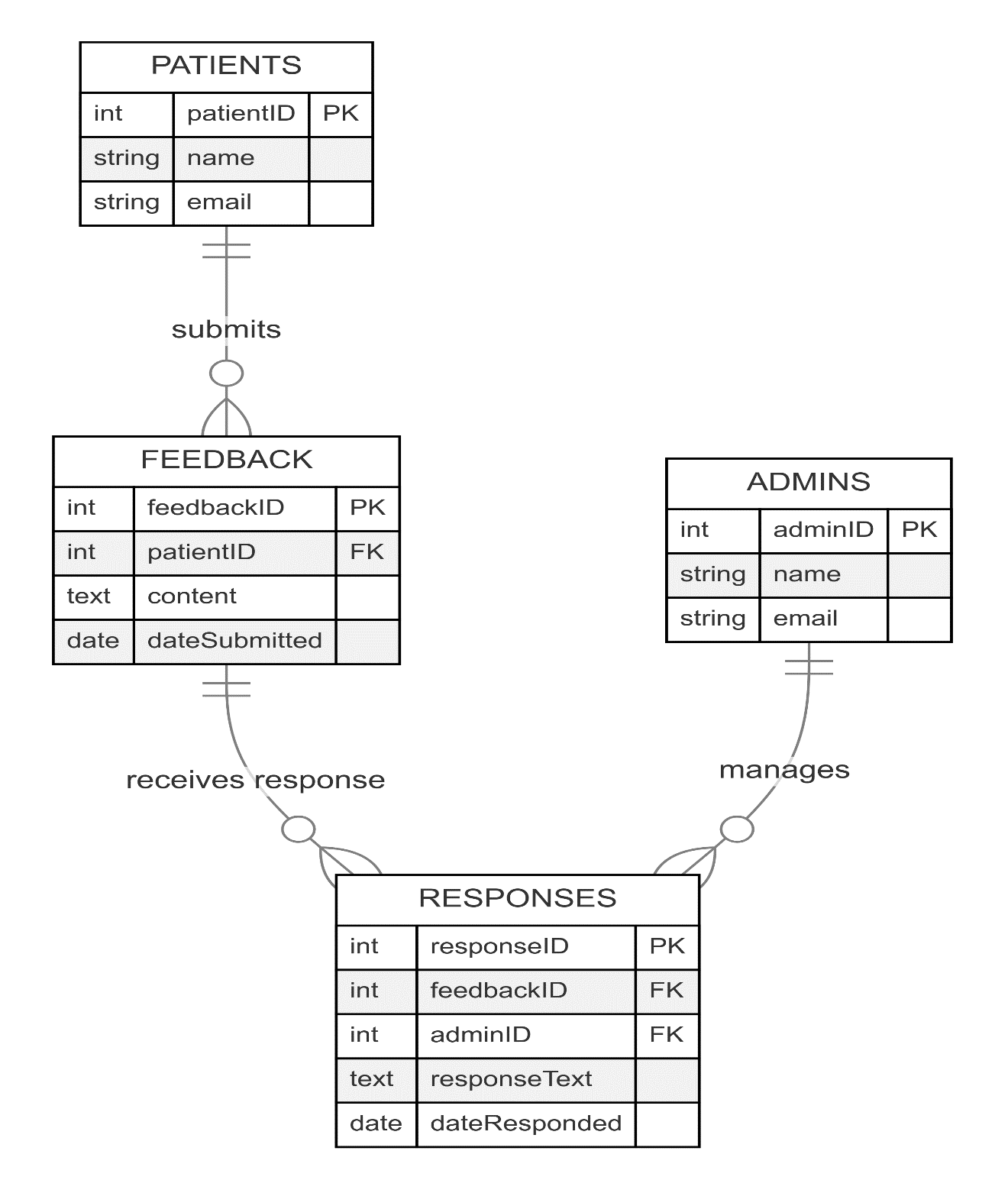
Foreign Key - feedbackID (Responses)

1. *An admin manages responses*

One-to-Many Relationship (An admin can provide multiple responses, but each response is linked to only one admin).

Primary Key - adminID (Admins)

Foreign Key - adminID (Responses)



**Entity-Relationship Diagram for the Patient Feedback Management System**

## Logical Design

The Logical Design of the Patient Feedback Management System (PFMS) captures the structure, behavior, and functionality of the system. It provides a detailed representation of system components, processes, and non-functional considerations to ensure efficiency, scalability, and security. This section defines the system architecture, control flow, and mechanisms for handling security and performance optimization.

### System Architecture

The system follows a Client-Server Architecture implemented using a three-tier model:

*Presentation Layer (Client-Side)*

Developed using Flutter for Android application development.

Provides an intuitive interface for patients and administrators.

Handles user interactions such as feedback submission, notifications, and responses.

*Application Layer (Backend Services*

Uses Firebase Functions to process system requests.

Implements business logic, including user authentication, data validation, and notifications.

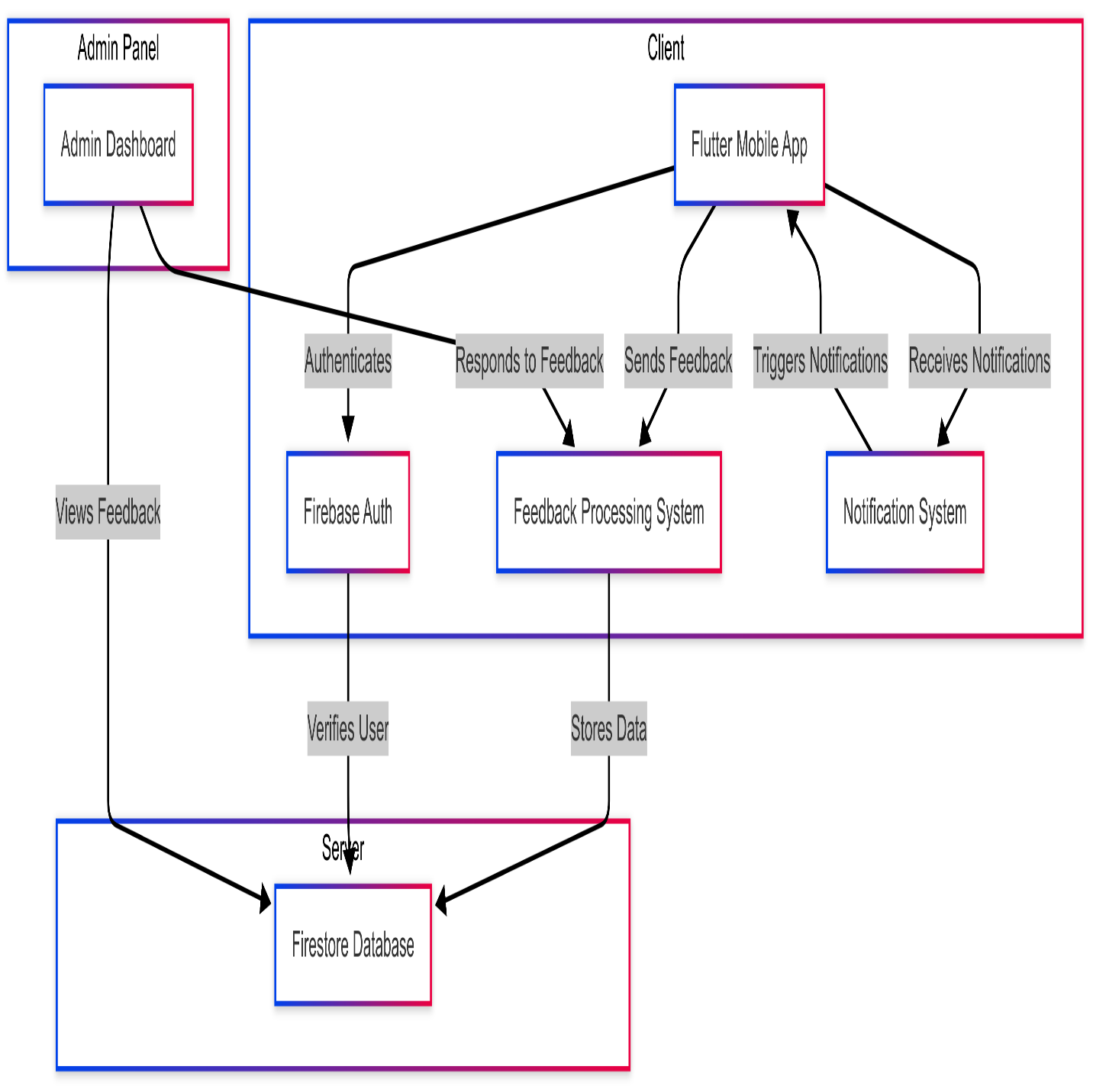
Uses RESTful APIs for external integrations if needed.

*Data Layer (Database & Storage)*

Firebase Firestore stores structured feedback data.

Firebase Storage is used for multimedia attachments (voice recordings, images).

Implements data indexing and retrieval optimization for efficient processing.

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**Component Diagram (Illustrates how system modules interact).**

### Control Flow and Process Design

The control flow represents how the system processes feedback and user interactions. The system follows these structured processes:

#### Patient Feedback Submission Process

*Actors Involved* - Patient, System, Database

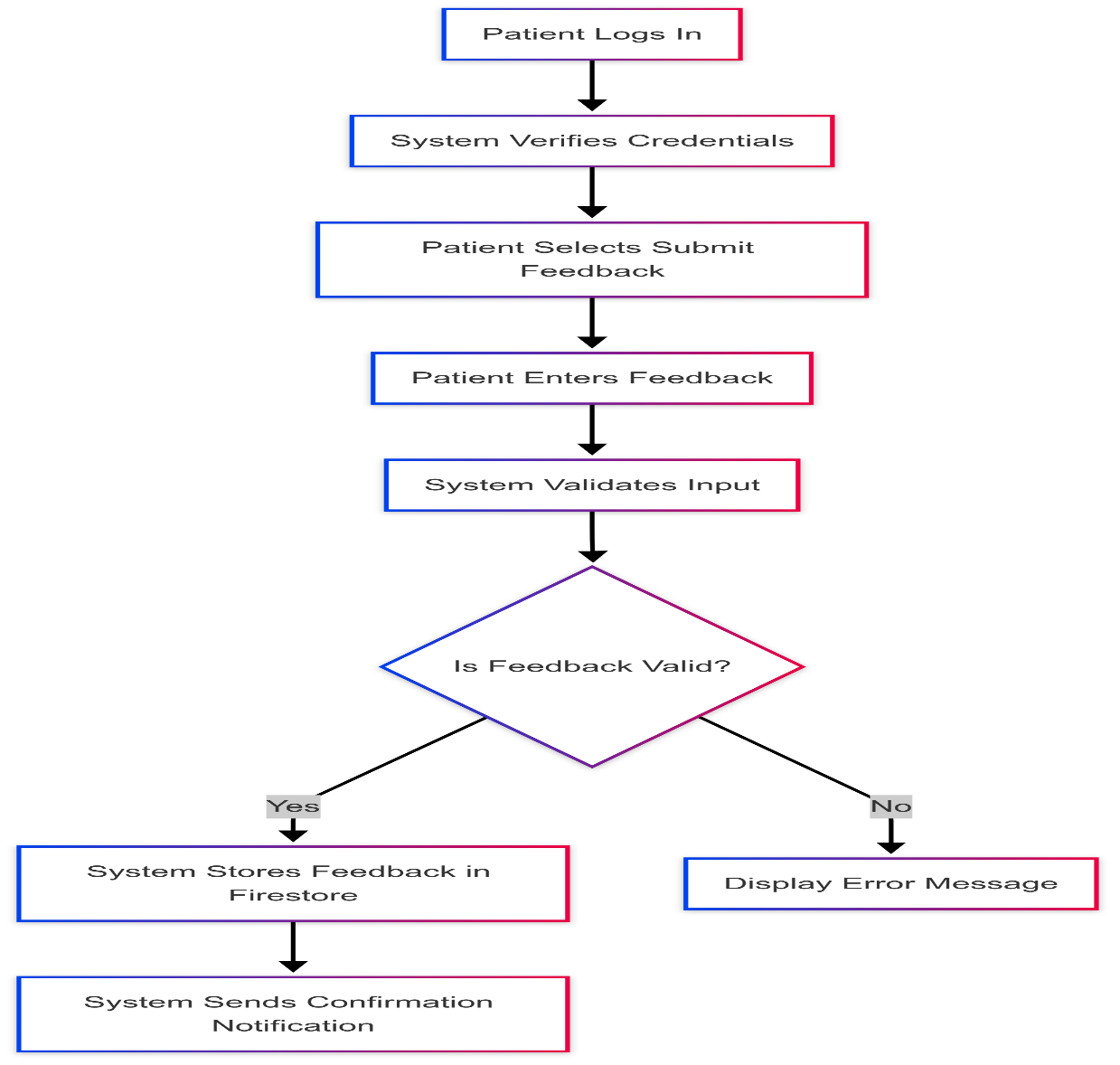
Patient logs into the system.

System authenticates the patient using Firebase Authentication.

Patient submits feedback (text, rating, or voice recording).

System validates the feedback and stores it in Firebase Firestore.

System sends a confirmation notification to the patient.



#### Admin Feedback Management Process

*Actors Involved*- Admin, System, Database

Admin logs into the system.

System authenticates the admin using role-based access control.

Admin retrieves feedback records from Firestore.

Admin analyzes and categorizes feedback based on content.

Admin responds to patient feedback.

System stores the response and sends a notification to the patient.

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#### System Notification Process

When feedback is submitted, the system stores it in the database.

Firebase Cloud Messaging (FCM) triggers a notification to the patient.

Patient receives a push notification on their mobile device.

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**Data Flow Diagram (Illustrates data movement in the system).**

### Design for Non-Functional Requirements

#### Security Strategies

The system integrates robust security measures to protect sensitive user data:

Firebase Authentication ensures secure login with email, phone, and social authentication.

Role-Based Access Control (RBAC) restricts unauthorized users from accessing admin functionalities.

AES-256 Encryption protects patient feedback data stored in Firestore.

Secure HTTPS Protocol ensures encrypted communication between the client and server.

#### Error and Exception Handling

To enhance system reliability, the following error-handling mechanisms are in place:

User Input Validation to prevent empty or invalid feedback submissions.

Automatic Error Logging in Firebase to track and debug failures.

Graceful Failure Handling displays meaningful error messages instead of system crashes.

#### Performance Optimization

The system is optimized for speed and efficiency through:

Cloud Functions Execution for asynchronous backend operations.

Data Caching Mechanisms to reduce repeated database queries.

Optimized Firestore Queries using indexing for quick data retrieval.

Load Balancing in Firebase Hosting for handling multiple user requests efficiently.

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