Real-Time Bus ID Verification and Tracking

**24-FYP-204**



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# Declaration

We hereby declared that this document is completely written by us, and it is totally our effort and none of anyone from outside of our group has copied it. This Report is purely written technically in accordance with our project.

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**Abstract**

Efficient and secure transportation is vital for educational institutions, where thousands of students rely on daily commutes. However, current systems face significant challenges, including inefficiencies, security vulnerabilities, and a lack of real-time tracking and communication. Issues such as overcrowding, unauthorized access, and poor resource utilization arise when students board buses without proper verification. Additionally, the absence of real-time bus monitoring and effective communication channels leads to confusion, delays, and suboptimal transport management.

The *Real-Time Bus ID Verification and Tracking* system addresses these challenges by integrating advanced technologies like RFID-based ID verification, live GPS tracking, and automated communication tools. The system ensures only authorized students access transport services, provides real-time visibility of bus locations for students, parents, and administrators, and enables timely updates regarding delays, route changes, or emergencies. It also tracks driver performance, monitors bus occupancy, and generates insights for optimizing route planning and capacity utilization.

By modernizing transport operations, the *Real-Time Bus ID Verification and Tracking* system enhances safety, boosts operational efficiency, and delivers a reliable and user-friendly commuting experience. This solution is an ideal choice for educational institutions aiming to transform their transportation infrastructure with secure and efficient technology.

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# List of Abbreviations

|  |  |
| --- | --- |
| RT-BIVT | Real-Time Bus ID Verification and Tracking |
| RFID | Radio Frequency Identification |
| RT-BIVT system | Admin Panel, Driver and Student App’s |
|  |  |
|  |  |

# CHAPTER 1

# Introduction

Efficient and secure transportation systems are crucial for educational institutions of all sizes, where thousands of students rely on daily commutes. However, many institutions face significant challenges, including inefficiencies, security vulnerabilities, and a lack of real-time tracking and communication. Students often board buses without proper verification, leading to overcrowding, unauthorized access, and inequitable usage of transport resources. Additionally, the absence of real-time monitoring for buses and driver performance, coupled with ineffective communication channels, results in confusion, delays, and poor management of transport operations.

To address these challenges, we propose a **RT-BIVT** system tailored for educational institutions. This system combines advanced technologies like **RFID**-based ID verification, live **GPS** tracking, and automated communication tools to streamline transportation management. It ensures that only authorized students access transportation services, provides real-time visibility of bus locations for students, parents, and administrators, and facilitates timely updates on delays, route changes, or emergencies. Additionally, the system tracks driver performance, monitors bus occupancy, and generates alerts to optimize route planning and capacity utilization.

This innovative solution goes beyond solving existing challenges—it transforms transportation management into a secure, efficient, and user-friendly ecosystem. By integrating modern technologies, the **RT-BIVT** system enhances safety, improves operational efficiency, and delivers a reliable transportation experience, making it an ideal choice for any educational institution seeking to modernize its transport infrastructure.

## Real-Time Bus ID Verification and Tracking System

The **RT-BIVT** system is an innovative solution designed to enhance transportation efficiency and safety for educational institutions. It integrates cutting-edge technologies like **RFID** for ID verification, live **GPS** tracking, and an advanced communication framework to create a streamlined, user-friendly transportation management ecosystem. This system empowers institutions to optimize bus routes, manage capacity, and monitor driver performance, ensuring a secure and efficient transport experience for students, parents, and administrators.

## Reason to Develop

The development of the RT-BIVT system is driven by several compelling factors, despite the existence of other transportation solutions:

### Addressing Unique Institutional Needs

Educational institutions often face specific challenges like unauthorized access, overcrowding, and inefficient communication. Generic transport management systems fail to meet these tailored needs, prompting the creation of a solution that directly addresses the unique requirements of such environments.

### Enhancing Safety and Security

Ensuring that only authorized students use transport facilities is crucial for security and fairness. RFID-based verification provides a reliable, real-time solution to mitigate misuse and enhance safety for students and drivers.

### Bridging Communication Gaps

A lack of effective communication between transport departments, parents, and students leads to confusion and inefficiency. The proposed system integrates real-time notifications for updates like delays, route changes, and emergencies, ensuring timely and clear communication.

### Optimizing Resource Management

Overcrowding or underutilization of buses is a common issue. By integrating occupancy monitoring and route optimization, this system helps administrators allocate resources more efficiently, reducing costs and enhancing comfort.

### Scalability and Adaptability

The system is designed to adapt to the specific challenges of any educational institution, whether managing a small fleet or a large-scale transport network. It is scalable, ensuring that institutions can continue to benefit as their transportation needs evolve.

This project is more than a technological upgrade; it is a strategic initiative to modernize transport systems, improve safety, and deliver a seamless experience for all stakeholders in an educational environment.

## Problem Statement

Educational institutions face significant challenges in managing their transportation systems effectively. Common issues include overcrowded or underutilized buses, unauthorized access, inefficient communication, and a lack of real-time tracking. These problems result in confusion, operational inefficiencies, and safety concerns for students, parents, and administrators. Existing solutions often lack the integration and adaptability required to address these specific institutional needs.

## Purpose

The primary purpose of the RT-BIVT system is to provide a seamless, all-in-one solution for transportation management in educational institutions. By combining secure access verification, live GPS tracking, and advanced communication tools, the system aims to improve operational efficiency, enhance student safety, and streamline communication among all stakeholders.

## Project Goals

* Implement secure ID verification to prevent unauthorized access.
* Provide live bus location tracking for real-time visibility and improved coordination.
* Enable real-time notifications for updates such as delays, route changes, or emergencies.
* Track key metrics like speed, stop intervals, and adherence to schedules.
* Streamline bus scheduling, capacity management, and route planning.
* Ensure an intuitive interface for administrators, parents, and students.

## Objectives

Objectives of the project are as follows:

* Integrate RFID-based ID verification to ensure only authorized users board the buses.
* Provide GPS-enabled tracking for buses accessible to students, parents, and administrators.
* Enable alerts for overcrowding or underutilization to optimize bus capacity.
* Monitor driver behaviour to ensure adherence to safety and efficiency standards.
* Develop a mobile app for notifications and updates to keep all stakeholders informed.

## Project Scope

Although designed for educational institutions, this system can be extended to other domains such as corporate transport, public transit, or private bus fleets. Its modular design allows for customization and scalability, making it suitable for varying transportation requirements and operational complexities.

## Proposed Solution

The system offers a modular and comprehensive approach to transportation management. It features real-time ID verification using **RFID**, live **GPS** tracking for buses, occupancy alerts, driver performance monitoring, and mobile apps for seamless communication. By adopting this system, institutions can significantly enhance operational efficiency, reduce resource wastage, and ensure a safer, more reliable transport experience for all users.

## Project Scheduling

Here is the Gantt chart for the RT-BIVT project. This chart visually represents the project timeline, including the start and end dates for each activity. It provides a high-level overview of how the project tasks are scheduled over time, aiding in effective project management and tracking. The timeline of the project is shown by the Gantt chart in Figure 1.1.

*Figure 1.1 Gantt Chart*

**CHAPTER 2**

1. **Literature Review**

The University Buses Management System (UBMS) aims to enhance transportation services for students and parents by integrating technologies such as RFID scanning, GPS tracking, real-time data analytics, and mapping services. This chapter reviews existing literature and technologies pertinent to the project, including RFID technology in transportation systems, GPS-based bus tracking, load management in public transportation, predictive arrival systems, and the utilization of mapping APIs like Google Maps and Mapbox. Additionally, it examines existing student transportation management systems to identify current solutions and gaps.

* 1. **Related Work**

Several transportation management systems cater to student transit needs, offering features like GPS tracking, route optimization, and parent communication. Notable examples include:

### Tyler Technologies’ Student Transportation Software

Provides integrated solutions for bus routing, fleet maintenance, and parent communication, connecting various aspects of transportation management.

[Tyler Technologies](https://www.tylertech.com/products/student-transportation?utm_source=chatgpt.com)

### Transfinder

Offers school bus tracking and routing solutions, emphasizing efficient route planning and real-time tracking to enhance safety and operational efficiency.

[Transfinder](https://www.transfinder.com/?utm_source=chatgpt.com)

### Edulog

Combines school bus routing, GPS fleet tracking, student ridership management, and parent communication apps into a single platform, aiming to streamline transportation operations.

[Edulog](https://www.edulog.com/?utm_source=chatgpt.com)

### Loqqat

Provides a smart real-time school bus tracker and management software, enabling route scheduling and live tracking to ensure student safety.

[Loqqat](https://loqqat.com/?utm_source=chatgpt.com)

## RFID Technology in Transportation Systems

Radio Frequency Identification (RFID) is extensively used in transportation for access control and user validation. Embedding RFID tags in student cards facilitates automated scanning and validation, ensuring user authenticity. Studies highlight RFID’s reliability, speed, and accuracy in real-time scenarios, making it suitable for monitoring passenger eligibility in bus systems.

In UBMS, RFID technology plays a crucial role in validating fee payment and ensuring time-based scanning, which enhances security and prevents misuse. The integration of RFID with time constraints ensures compliance and builds trust among stakeholders.

## GPS-Based Bus Tracking

GPS technology has transformed public transportation by enabling real-time vehicle tracking. It allows passengers and administrators to monitor bus locations, enhancing operational transparency and service quality. Research shows that GPS tracking improves user satisfaction by providing accurate location updates and estimated arrival times (ETA).

In UBMS, GPS tracking enables parents and students to plan their journeys effectively. Combined with predictive algorithms, GPS data ensures accurate ETAs and facilitates driver accountability. It also provides valuable data for optimizing bus routes and schedules.

## Load Management in Public Transportation

Load management is critical in public transportation, as overloading can lead to safety concerns and underutilization can cause inefficiencies. Techniques such as weight sensors and real-time passenger counting are effective for monitoring bus capacity.

UBMS incorporates real-time load analysis to ensure passenger safety and optimize bus fleet utilization. By combining load data with historical patterns, the system can predict demand and adjust operations accordingly.

## Predictive Arrival Systems

Predictive arrival systems leverage GPS data, traffic patterns, and historical records to provide accurate ETAs. Studies indicate that such systems enhance user trust and satisfaction. The integration of machine learning algorithms can further improve prediction accuracy.

In UBMS, predictive arrival features reduce waiting times and improve convenience for students and parents. These features, presented through intuitive interfaces, contribute to a positive user experience.

## Mapping APIs: Google Maps and Mapbox

Mapping services are integral to transportation management systems, providing visualization and geolocation functionalities.

### Google Maps API

Google Maps API is a comprehensive mapping solution offering features such as real-time traffic data, route planning, and ETA calculations. Its extensive database and reliability make it a popular choice for developers. In UBMS, Google Maps API plays a vital role in calculating ETAs and displaying real-time bus locations, enhancing the user experience.

### Mapbox

Mapbox is a customizable map SDK that enables developers to design tailored map experiences. It offers dynamic theming, offline maps, and robust integration capabilities. Mapbox’s flexibility and performance make it suitable for applications requiring specialized mapping solutions. For UBMS, Mapbox provides an opportunity to create branded, intuitive interfaces for users.

The choice between Google Maps API and Mapbox depends on project requirements, budget, and desired user experience. Both solutions are integral to building reliable transportation systems.

**CHAPTER 3**

1. **System Requirements**

The **University Buses Management System (UBMS)** is designed to streamline and enhance the efficiency of university transportation services by leveraging advanced technologies such as RFID, GPS tracking, and real-time analytics. This section outlines the system’s requirements, detailing both functional and non-functional aspects. The functional requirements define the core operations of the system, including user authentication, journey management, and live bus tracking. Non-functional requirements emphasize attributes like performance, security, usability, and scalability to ensure the system’s reliability, robustness, and user-friendliness. Together, these requirements form the foundation for implementing a system that meets the needs of students, parents, drivers, and university administrators, while providing a scalable and maintainable solution for future enhancements.

* 1. **Functional Requirements**

### User Authentication and Authorization:

* The system must allow Super Admin, Admin, Driver, Conductor, and *Student* to log in using valid credentials.
* The system must provide a *sign-up module* for Super Admin to create Child Admin accounts and assign permissions.
* The system must verify user roles to grant access to specific modules.

### Bus and Route Management

* The Admin must be able to add, update, or delete bus details.
* The Admin must define territories or routes for buses.
* The Driver must be able to record and update routes for specific buses.
* The Admin must view the list of available buses and their assigned routes.

### Journey Management

* The Driver must be able to initiate or end a journey.
* The system must track the live location of buses during an active journey.
* The Driver must authenticate student cards when they board the bus.
* The system must record journey data, including the bus number, route taken, boarded students, and the driver responsible.
* Admin and Students must have access to the bus’s live location.
* Admin must be able to view complete journey history for all buses.

### Bus Card Management

* Admin must assign bus cards to Students.
* Admin must be able to revoke or enable student bus cards.
* The system must verify student cards during boarding.

### Session and Student Management

* Admin must create or end sessions and set their expiry dates.
* The system must disable student cards automatically if the session expires or is deleted.
* The system must generate app credentials for Students when they are added to the system.
* Admin must be able to manage student data (add, update, delete).

### Bus Staff Management

* Admin must be able to add and manage Drivers and Conductors.
* The system must generate app credentials for Drivers and Conductors upon registration.

### Complaint Management

* Students and Drivers must be able to submit complaints through their apps.
* Admin must have a module to view, address, and resolve complaints.
* The system must maintain a record of all complaints and their statuses.

### Announcement Management

* Admin must be able to create and manage announcements.
* The system must deliver announcements as notifications to Drivers and Students through their apps.

### Notification and Alerts

* The system must send notifications to Students and Drivers for announcements, route updates, or other relevant information.
* The system must alert Admin if a bus deviates from its assigned route or goes out of its territory.

### Live Location Tracking

* The system must track the real-time location of buses during active journeys.
* Admin and Students must access live bus locations via their apps.
* The system must record location data for journey history and analysis.

### Data Management

* The system must store and manage records for buses, routes, journeys, users, and complaints.
* The system must maintain logs of all system actions for accountability.

* 1. **Non-Functional Requirements**

### Security:

Implement robust authentication and authorization checks.

### Availability:

The system should be available 24/7.

### Scalability:

The system must be scalable to handle an increasing number of users and data.

### Usability:

User interface should be intuitive and easy to navigate.

### Maintainability:

The system should be easy to maintain and update with minimal downtime.

### Performance

The system should deliver real-time updates and respond to user actions promptly.

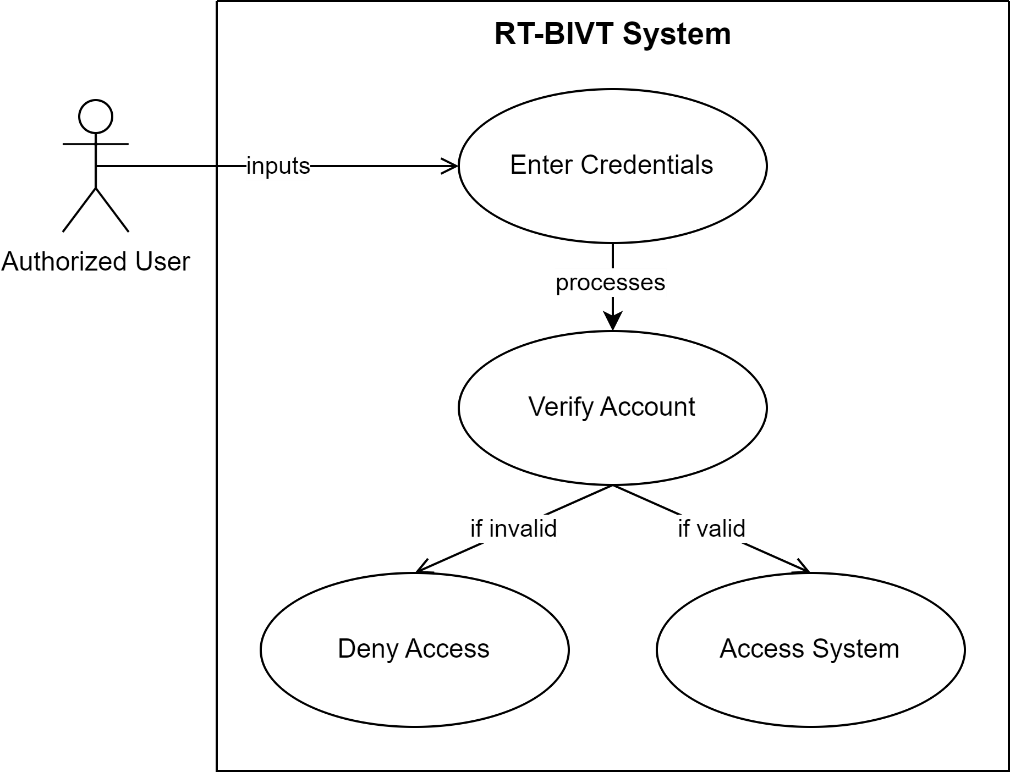
### Efficiency

The system should optimize resource usage and minimize latency during operations.

## Use Case Diagram

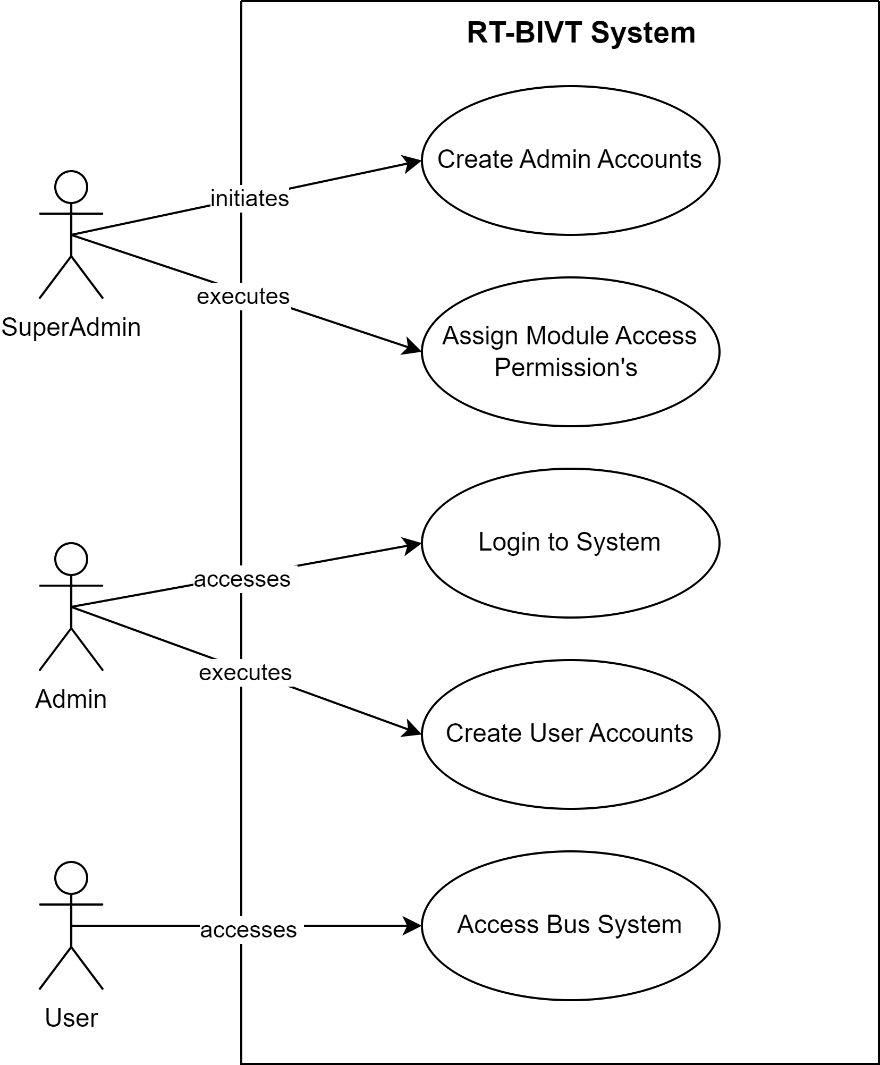
For graphical visualization of actor interaction with the components of the systems, the most appropriate approach is to use case diagrams that graphically represent which actor may perform or access which functionality or component of the system.

### Use Case of Sign In



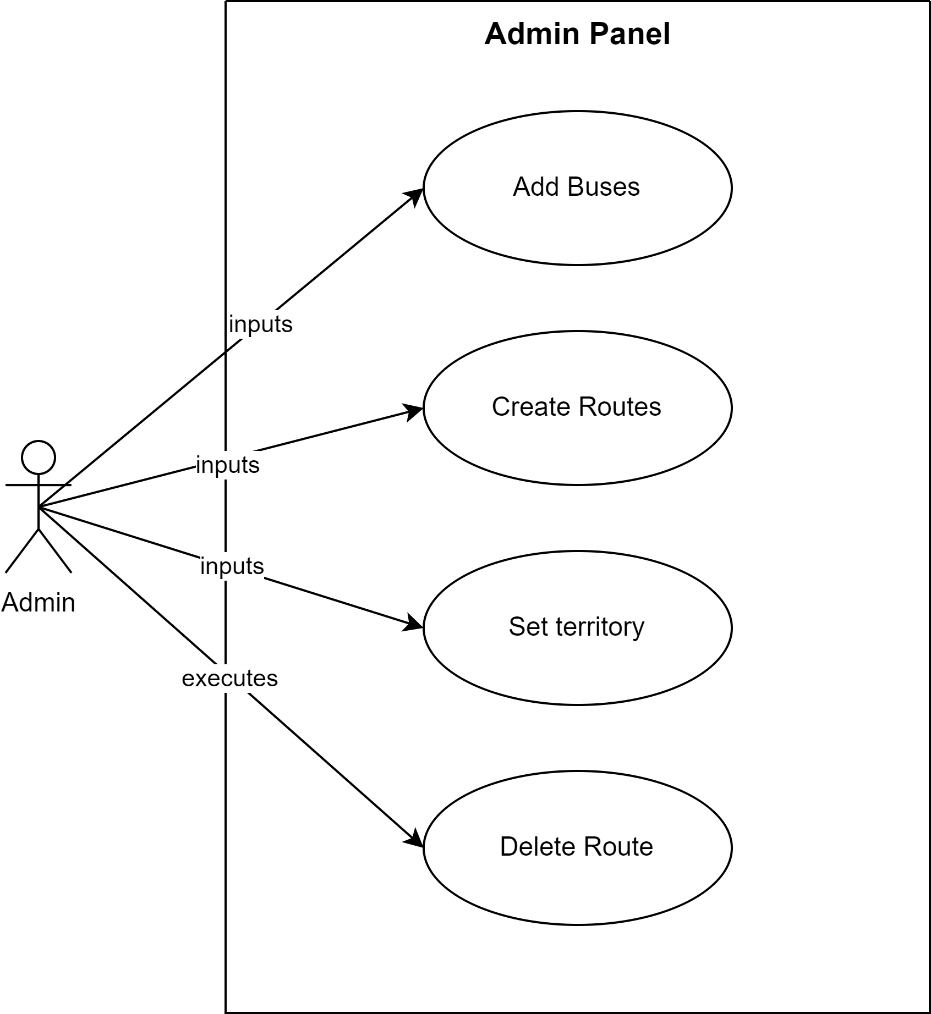
*Figure 3.3.1 Use Case of Sign In*

### Use Case of Sign Up



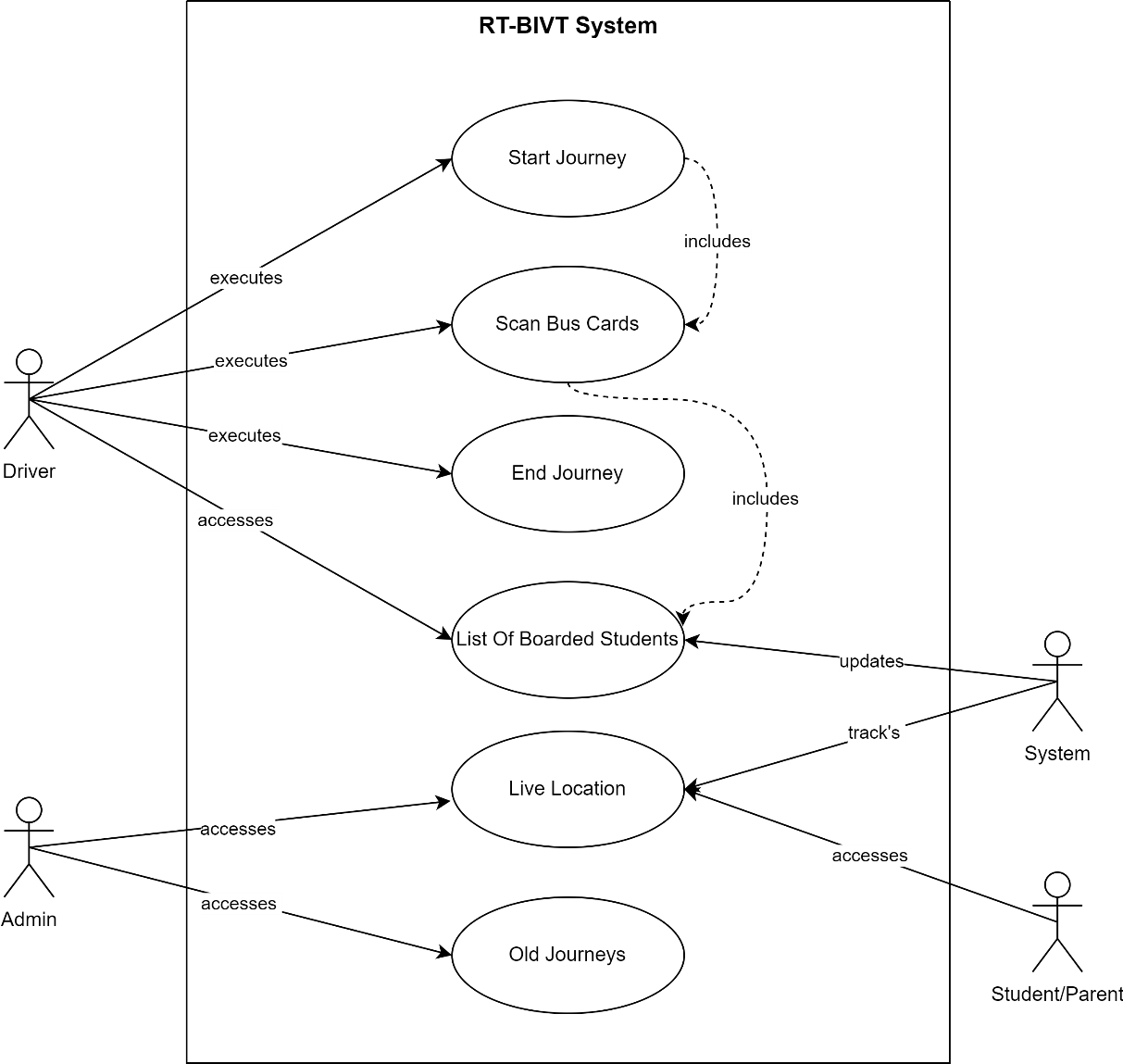
*Figure 3.3.2 Use Case of Sign Up*

### Use Case of Bus and Route Management

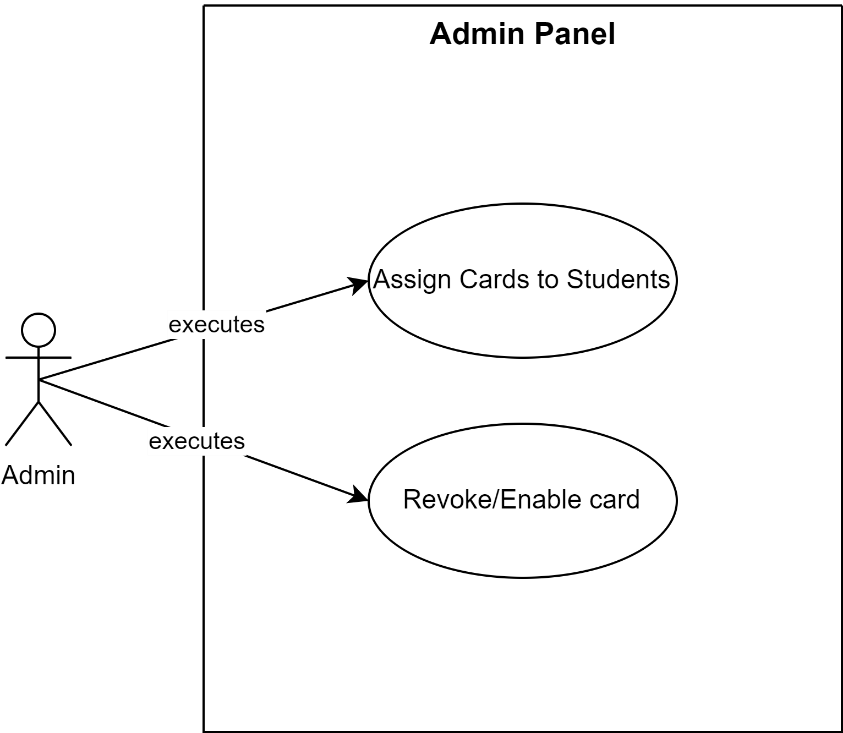


*Figure 3.3.3 Use Case of Bus and Route Management*

### Use Case of Journey Management

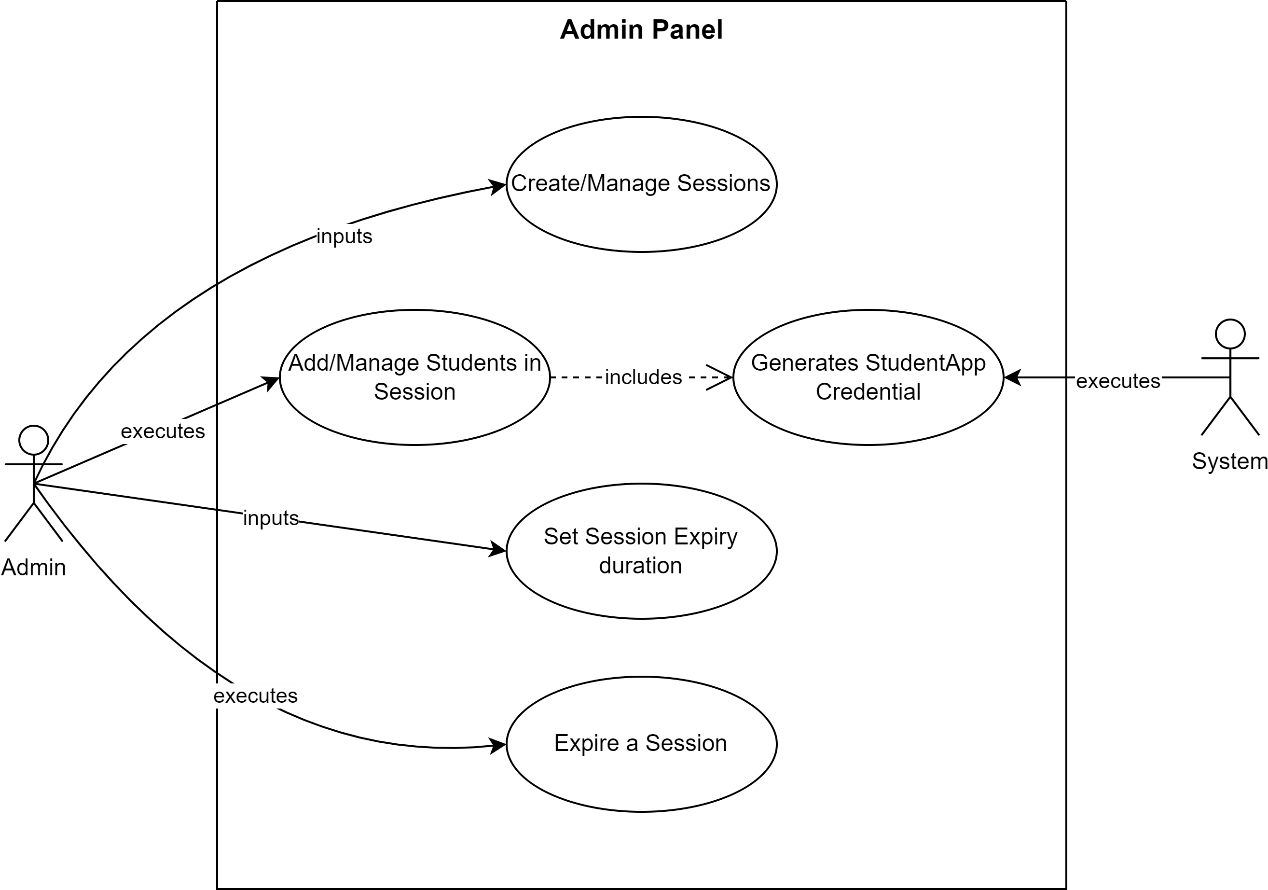
*Figure 3.3.4 Use Case of Journey Management*

### Use Case of Bus card Management



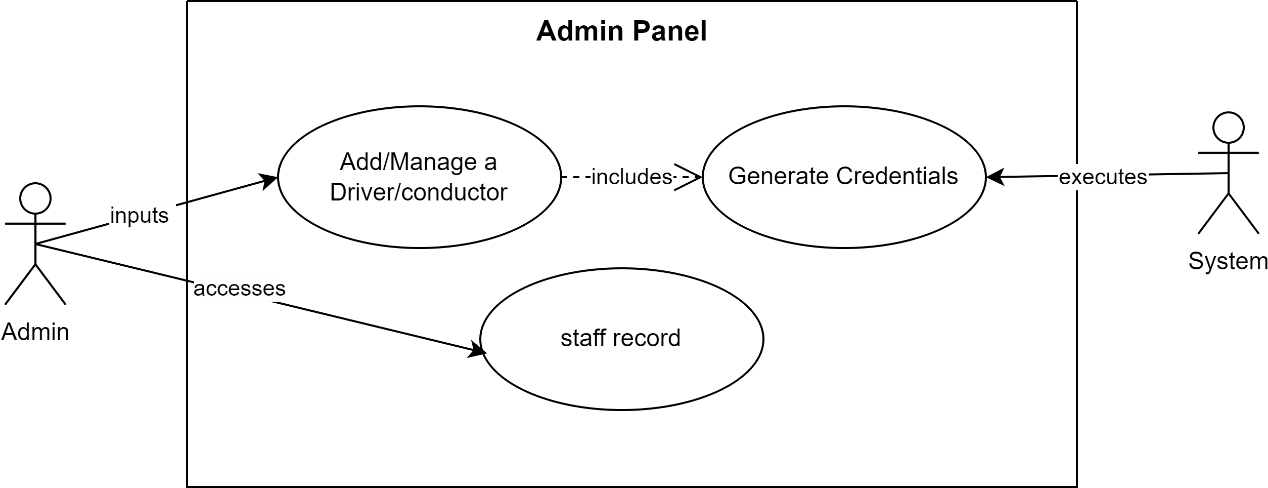
*Figure 3.3.5 Use Case of Bus Card Management*

### Use Case of Student & Session Management



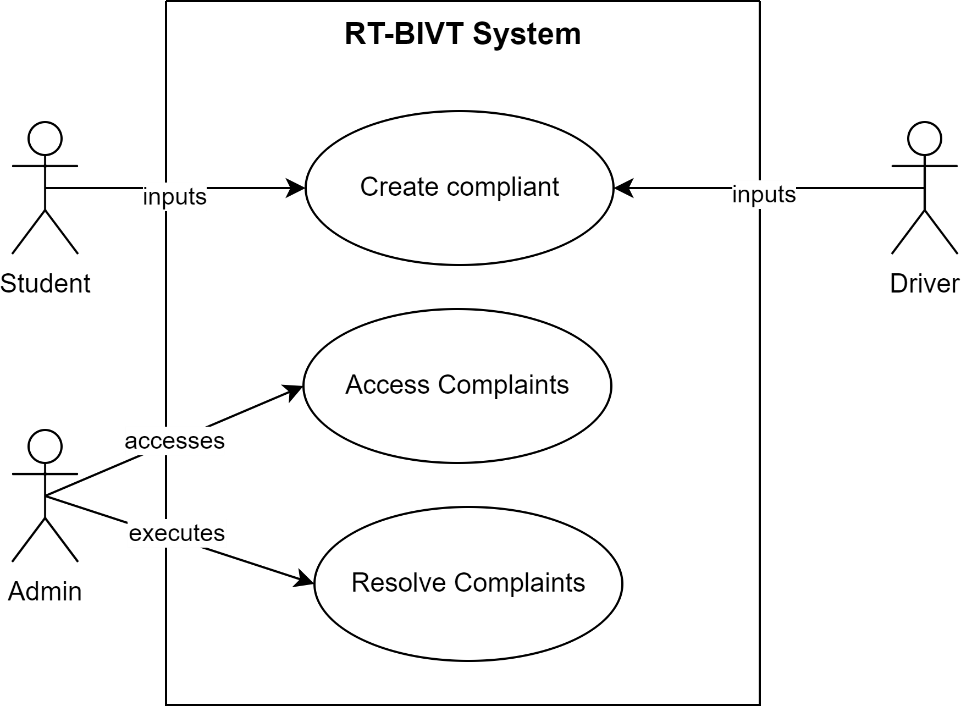
*Figure 3.3.6 Use Case of Student & Session Management*

### Use Case of Bus Staff Management



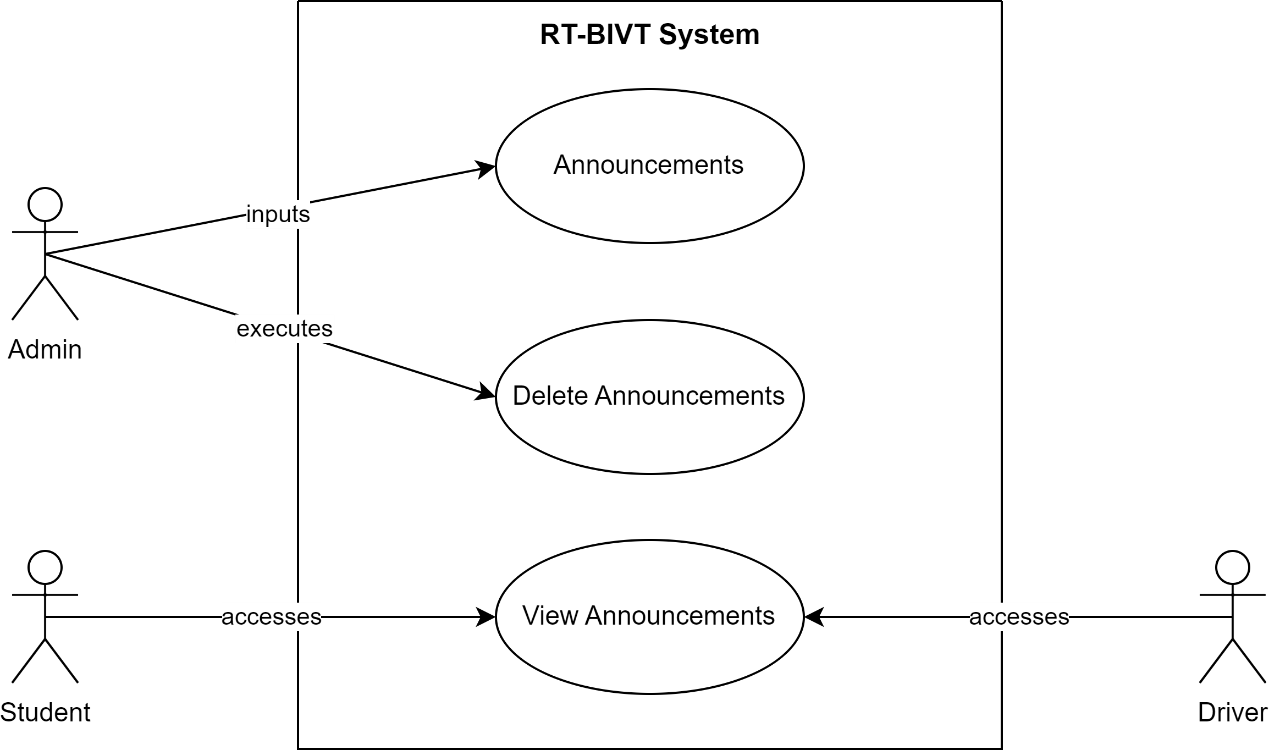
*Figure 3.3.7 Use Case of Bus Staff Management*

### Use Case of Complaint Management

**

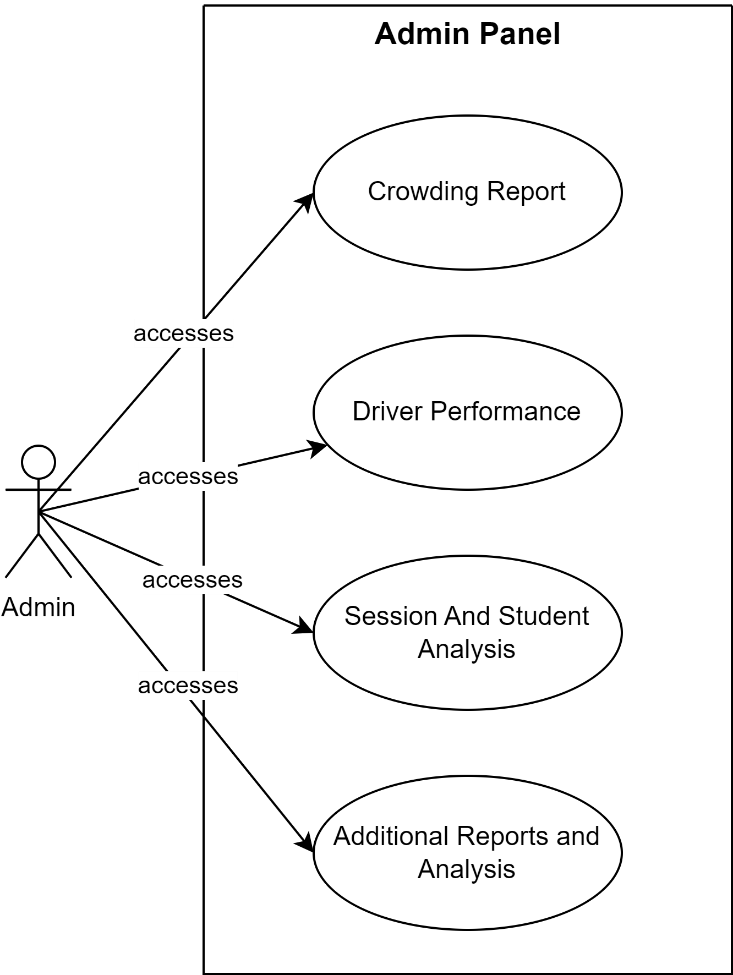
*Figure 3.3.8 Use Case of Complaint Management*

### Use Case of Announcement Management



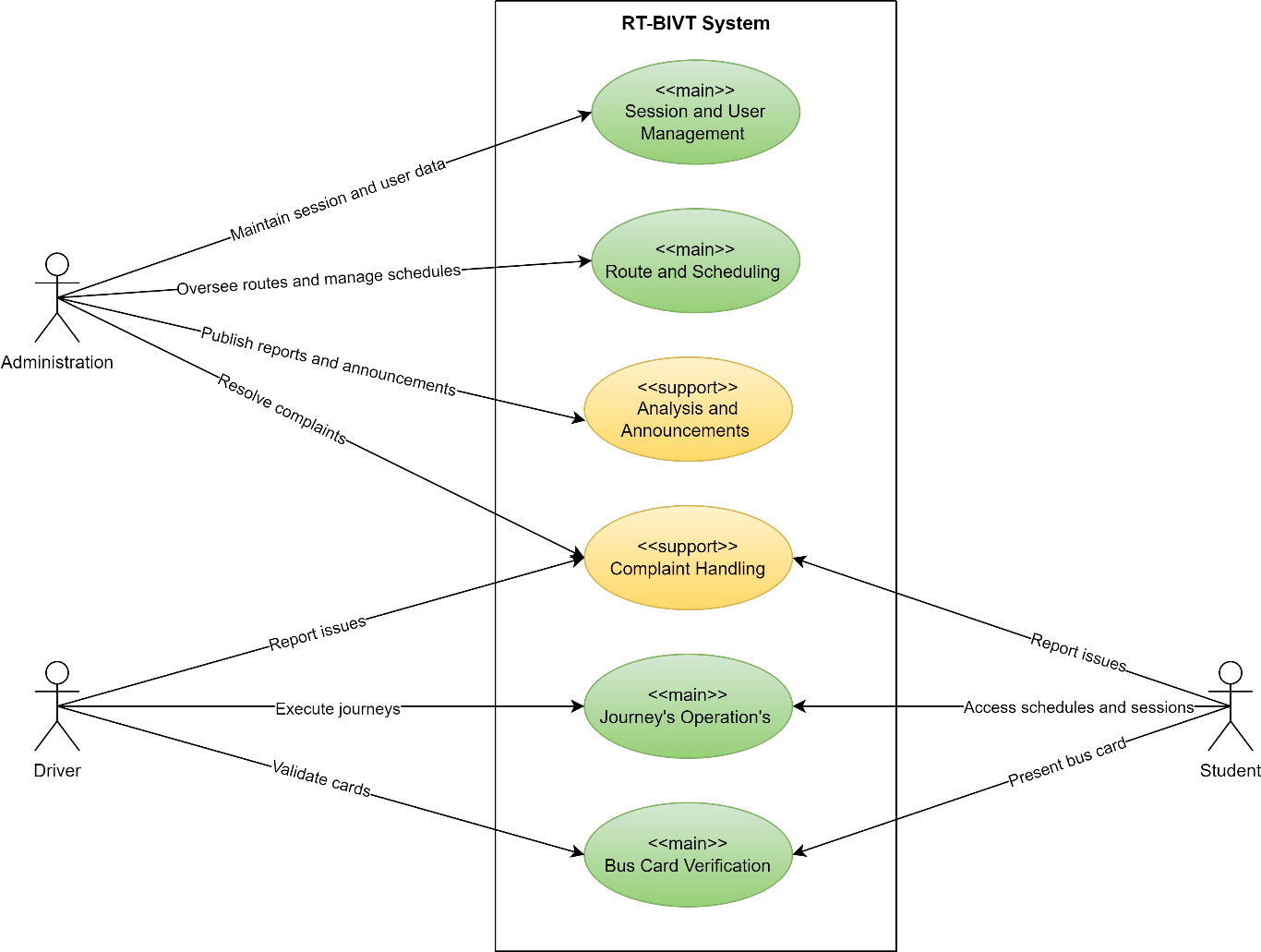
*Figure 3.3.9 Use Case of Announcement Management*

### Use Case of General Functionalities



*Figure 3.3.10 Use Case of General Functionalities*

### Use Case of Complete System

**

*Figure 3.3.11 Use Case of Complete System*

## Use Case Description.

Use case description contains every piece of information (use case id, use case name, description, pre- and post-conditions) of each use case.

### Description of Sign In:

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 01 |
| Use Case Name | Sign In |
| Actors | Authorized User |
| Description | Authorized users log in to the RT-BIVT via provided applications. Access is denied if the user does not have an account or proper credentials. |
| Pre-condition | User must have an account and credentials. |
| Post-condition | User logs into the RT-BIVT system or is denied access. |

*Table: 3.4.1 Description of Sign In*

### Description of Sign Up:

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 02 |
| Use Case Name | Sign Up |
| Actors | Super Admin, Authorized User |
| Description | A Super Admin has the ability to create admins and assign specific roles and permissions to each. These admins are tasked with managing the creation of user accounts, including those for bus staff and students. |
| Pre-condition | User must have an account, enough permissions and credentials to access system. |
| Post-condition | A new user is created with specific roles and permissions to operate with in RT-BIVT. |

*Table: 3.4.2 Description of Sign Up*

### Description of Bus and Route Management:

*Table: 3.4.3 Description of Bus and Route Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 03 |
| Use Case Name | Bus and Route Management |
| Actors | Admin |
| Description | The admin is responsible for adding buses, defining routes, and assigning territories. |
| Pre-condition | Admin must be authenticated and have enough permissions to manage buses and routes. |
| Post-condition | The admin effectively oversees the management of buses, routes, and territories. |

### Description of Journey Management:

*Table: 3.4.4 Description of Journey Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 04 |
| Use Case Name | Journey Management |
| Actors | Admin, Driver, Student |
| Description | The driver starts and ends journeys while verifying student bus cards during the trip. The system logs journey-related data and tracks the bus's live location, enabling administration, students, and parents to access journey details and monitor the bus's real-time location. |
| Pre-condition | The driver must be authenticated and have specified the route and the bus they are assigned to. The student must possess a valid and active bus card. |
| Post-condition | The driver successfully operates the journeys, while the system tracks and updates the journey details and live bus location. This allows both administrators and students/parents to access the journey information and the live location of the bus. |

### Description of Bus Card Management:

*Table: 3.4.5 Description of Bus Card Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 05 |
| Use Case Name | Bus Card Management |
| Actors | Admin |
| Description | The admin is responsible for assigning and managing student bus cards. |
| Pre-condition | The admin must be authenticated and have necessary permissions to manage bus cards. Students are required to be registered in the system. |
| Post-condition | The admin can successfully assign bus cards to students, revoke the cards to prevent further use, and re-enable them when needed. |

### Description of Session and Student Management:

*Table: 3.4.6 Description of Session and Student Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 06 |
| Use Case Name | Session and Student Management |
| Actors | Admin, System |
| Description | The admin can create and terminate sessions, set session expiry, and manage students within the system. When a student is added, the system automatically generates app credentials for them. Expiring or deleting a session will deactivate all bus cards associated with that session. |
| Pre-condition | The admin must be authenticated and have necessary permissions to manage bus cards. Student data must be accurate and complete for the generation of credentials. |
| Post-condition | The admin effectively oversees both sessions and student management. |

### Description of Bus Staff Management:

*Table: 3.4.7 Description of Bus Staff Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 07 |
| Use Case Name | Bus Staff Management |
| Actors | Admin, System |
| Description | The admin oversees drivers and conductors. When a new staff member is added, the system automatically generates app credentials for them. |
| Pre-condition | The admin must be authenticated and have necessary permissions to manage bus staff. |
| Post-condition | The admin effectively manages bus staff. |

### Description of Complaint Management:

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 08 |
| Use Case Name | Complaint Management |
| Actors | Student, Driver, Admin |
| Description | Students and drivers are allowed to submit complaints about transportation services and related concerns. |
| Pre-condition | All users are required to be authenticated. Administrators must also be authenticated and possess the necessary permissions to manage complaints. |
| Post-condition | Complaints submitted by students and drivers get reviewed and resolved by the authorities. |

*Table: 3.4.8 Description of Complaint Management*

### Description of Announcement Management:

*Table: 3.4.9 Description of Announcement Management*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 09 |
| Use Case Name | Announcement Management |
| Actors | Admin, Driver, Student |
| Description | The admin shares announcements related to transportation. |
| Pre-condition | All users are required to be authenticated. |
| Post-condition | The administrator successfully posts announcements. |

### Description of General Functionalities:

*Table: 3.4.10 Description of General Functionalities*

|  |  |
| --- | --- |
| Field | Details |
| Use Case Id | 10 |
| Use Case Name | General Functionalities |
| Actors | Users |
| Description | The admin can generate reports and analyse valuable information extracted from the data currently stored. |
| Pre-condition | The admin must be authenticated and have necessary permissions. |
| Post-condition | Administration makes better decisions and enhances services through the analysis of current transportation data. |

# Chapter 4

## 4.1 Agile Software Development Methodology

Agile methodology is an iterative and incremental approach to software development that emphasizes flexibility, collaboration, and customer feedback. Unlike traditional methodologies like the Waterfall model, Agile allows for adaptive planning, evolutionary development, and continual improvement, enabling rapid and flexible responses to change. It is particularly effective in managing the complexity and unpredictability of software projects.

## 4.2 Selected Methodology: Agile

A software development methodology is a way to improve development work with the help of dividing the development process into distinct phases to make a system with better productivity. It also helps to structure and control the whole system. It involves different methodologies, also called the Software Development Life Cycle, that are stages for software development with a certain set of rules. Generically, we categorized the methodologies into Rapid application development and planned-driven. Waterfall, spiral is planned driven while agile is Rad based.

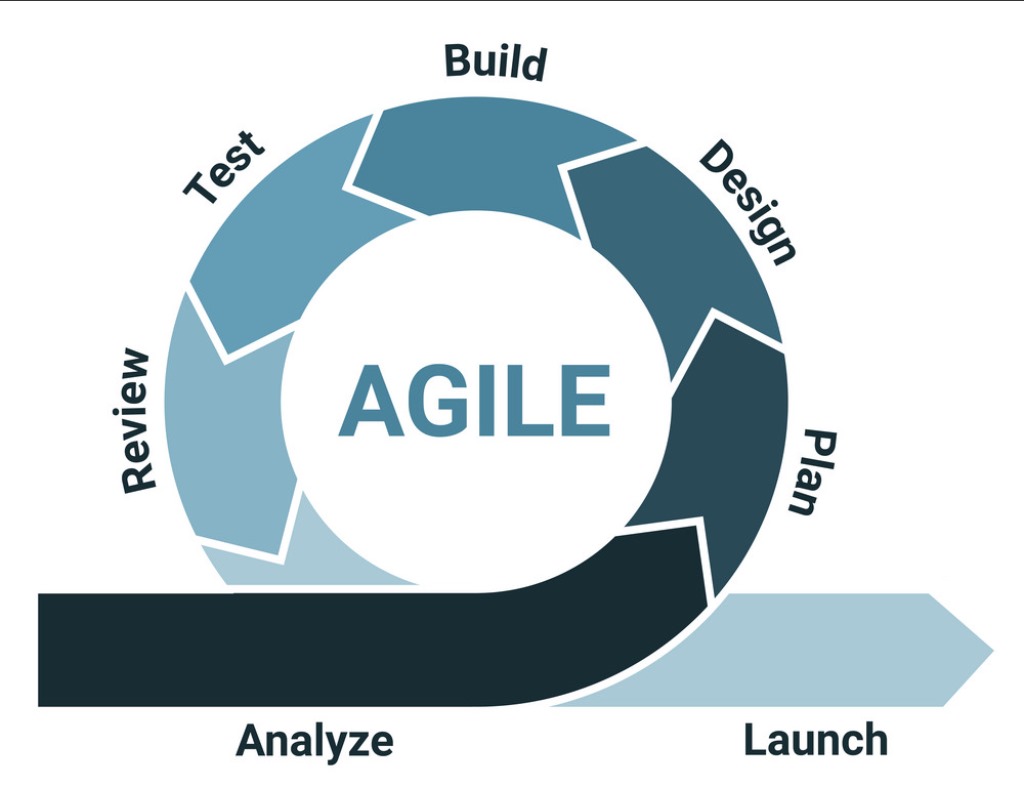
## 4.3 Reasons for Selecting Agile Methodology

1. **Flexibility and Adaptability**: Agile allows the project to adapt to changes in requirements and technology swiftly.
2. **Customer Collaboration**: Regular feedback from users ensures that the development aligns with the user's needs and expectations.
3. **Incremental Delivery**: Agile facilitates the delivery of small, workable segments of the project, ensuring a faster time-to-market and continuous improvement.
4. **Risk Management**: Regular reviews and iterations help in early identification and resolution of issues, reducing the overall risk.

## 4.4 Agile Project Planning and Execution for RT-BIVT

Agile project planning and execution involve the division of the project into sprints, with each sprint aimed at delivering a potentially shippable product increment. The key phases include:

1. **Product Backlog Creation**: Gather and prioritize necessities for the RT-BIVT undertaking, growing a product backlog.
2. **Sprint Planning**: At the start of every dash, pick a hard and fast of capabilities from the product backlog and plan their delivery.
3. **Daily Stand-ups**: Conduct day by day meetings to speak about development, demanding situations, and plan the day's paintings.
4. **Sprint Execution**: Develop, take a look at, and combine features inside the dash.
5. **Sprint Review**: At the quilt of every sprint, reveal the finished paintings to stakeholders and collect comments.
6. **Sprint Retrospective**: Reflect at the sprint to identify successes and regions for development.
7. **Release Planning**: Plan releases based totally at the undertaking progress, stakeholder comments, and marketplace situations.



*Figure 4.2 Agile Model*

# Chapter 5

# 5 System Architecture

## 5.1 Architecture

In widespread, structure is the manner of product planning, layout, and construction. The design section of the structure comes in the solution phase of the lifestyles cycle as it defines the machine because the primary software program components.

For our task, we've got decided on a Model-View-Template (MVT) structure, appropriate for applications the use of Django and React. This architecture is defined as follows:

* **Model**: Represents the application's information structures, normally mapped to database tables. It is liable for managing facts, processing user inputs, and managing interactions with the database or other statistics assets.
* **View (Django)**: In Django, perspectives handle the enterprise common sense and interact with the version to carry statistics and render a template. They act as a bridge among the Model and the Template.
* **Template (React)**: Templates are liable for rendering the records acquired from the views in a layout suitable for interaction with the user. In our challenge, this position is fulfilled via React, where components are used to create the user interface. These components may consist of HTML, CSS, and JavaScript documents, creating a dynamic and interactive consumer in revel.

By MVT architecture in this way, the undertaking benefits from improved modularity, maintainability, and scalability. It enables less complicated collaboration between developers, as every element - Model, View, and Template - can be advanced independently. Additionally, keeping apart the user interface (React Templates) from the underlying business common sense and data (Django Model and View) makes the utility extra adaptable to special platforms and technology.

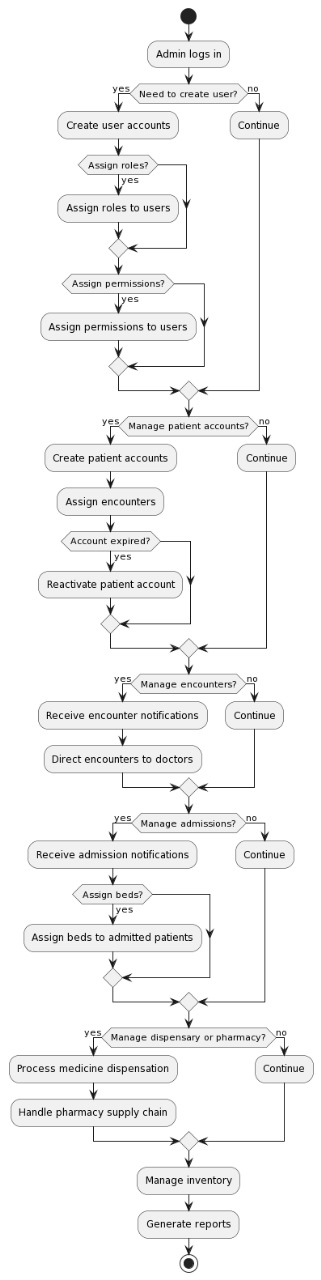
Diagram of a diagram of a computer

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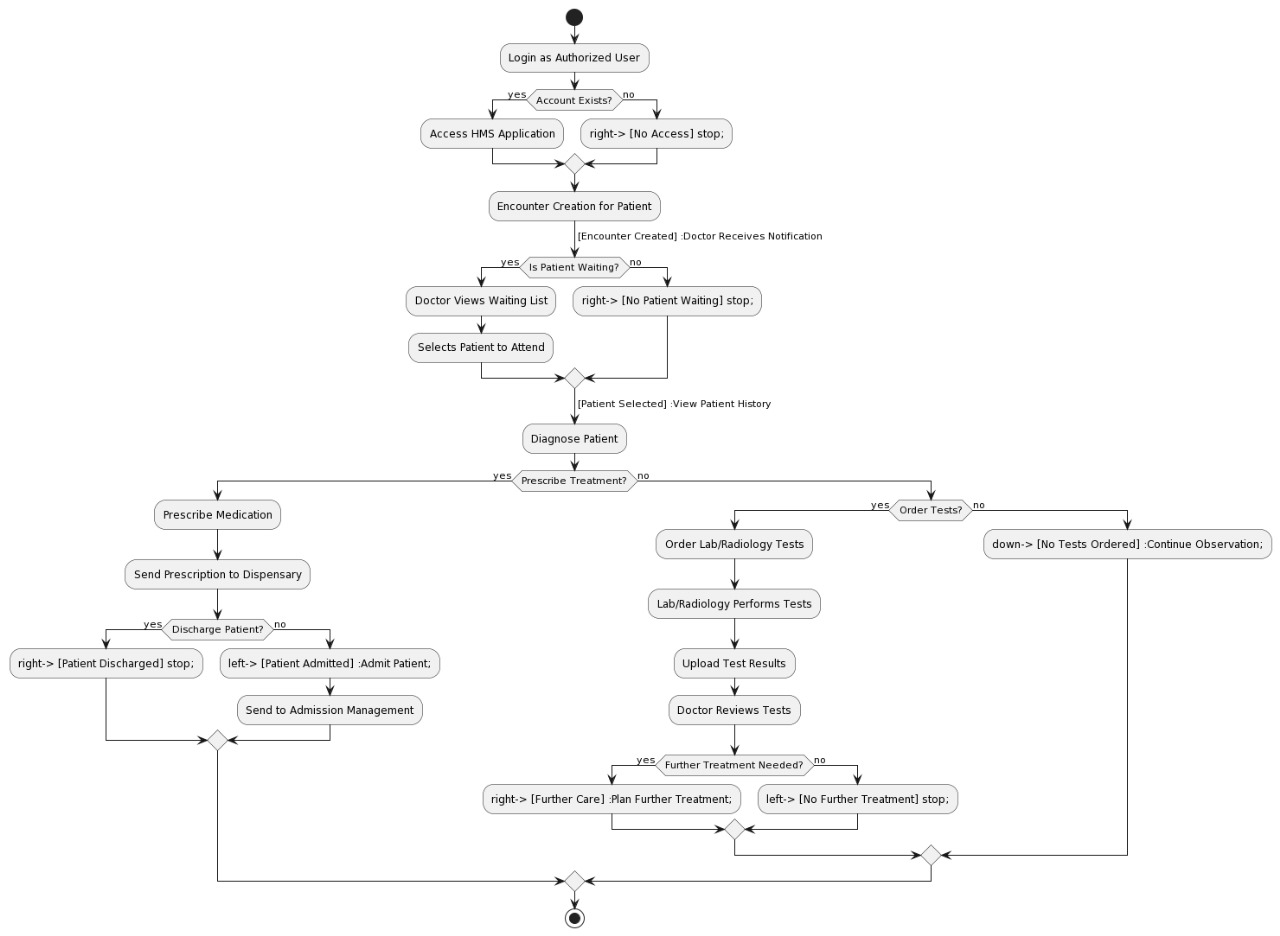
*Figure 5.1 Model, View and Template*

## 5.2 Activity Diagram

Activity Diagram shows the flow of the system from one activity to another. An activity is any set of action or set of actions that compare needs to perform any specific task, so mapping the overall actions of the system we can easily estimate the overall flow of the system, and that’s where activity diagrams are applicable.



*Figure 5.2.1 Activity of Admin Control*

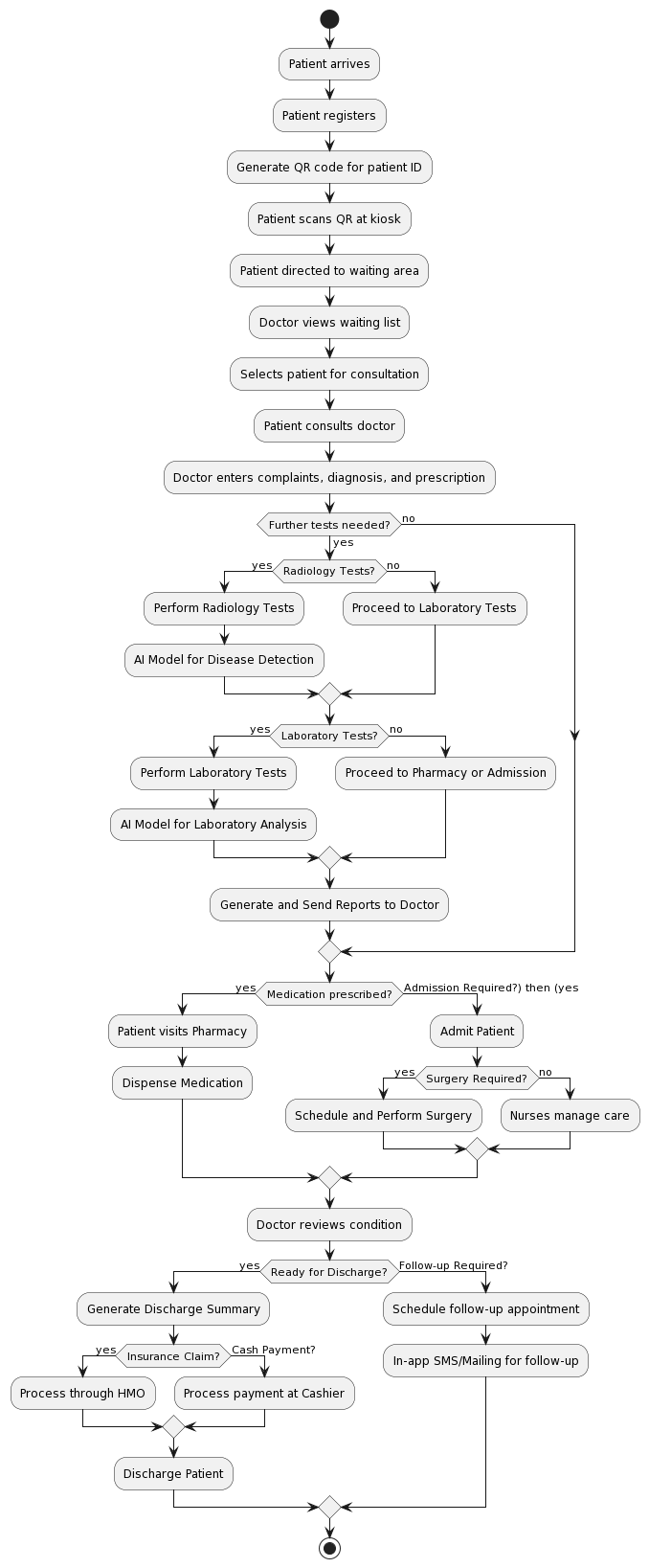


*Figure 5.2.2 Activity of Doctor, Nursing, Laboratory and Radiology Centre*

A diagram of a flowchart

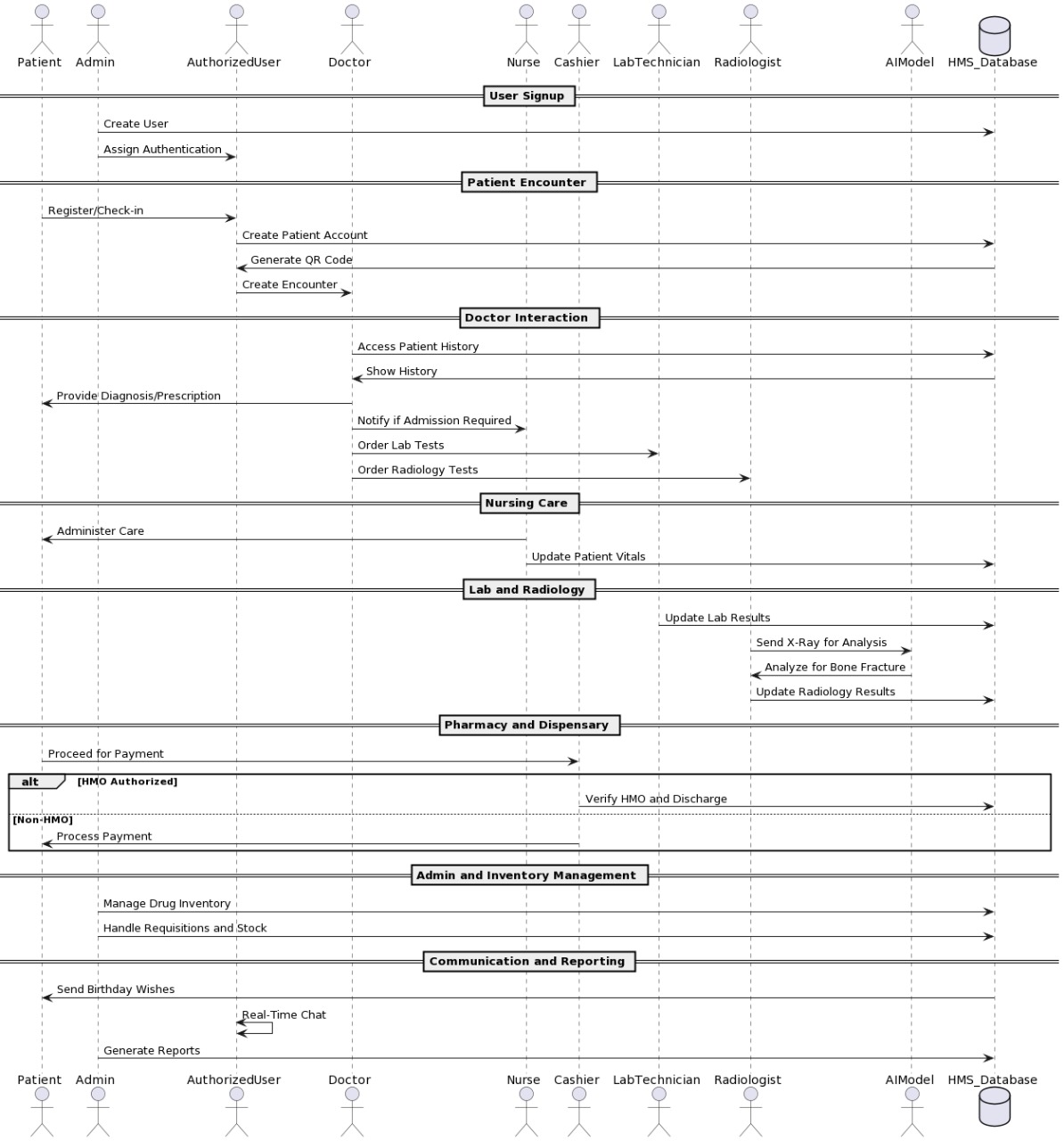
Description automatically generated

*Figure 5.2.3 Activity of Dispensary, Pharmacy, HMO Authorization, Cashier*

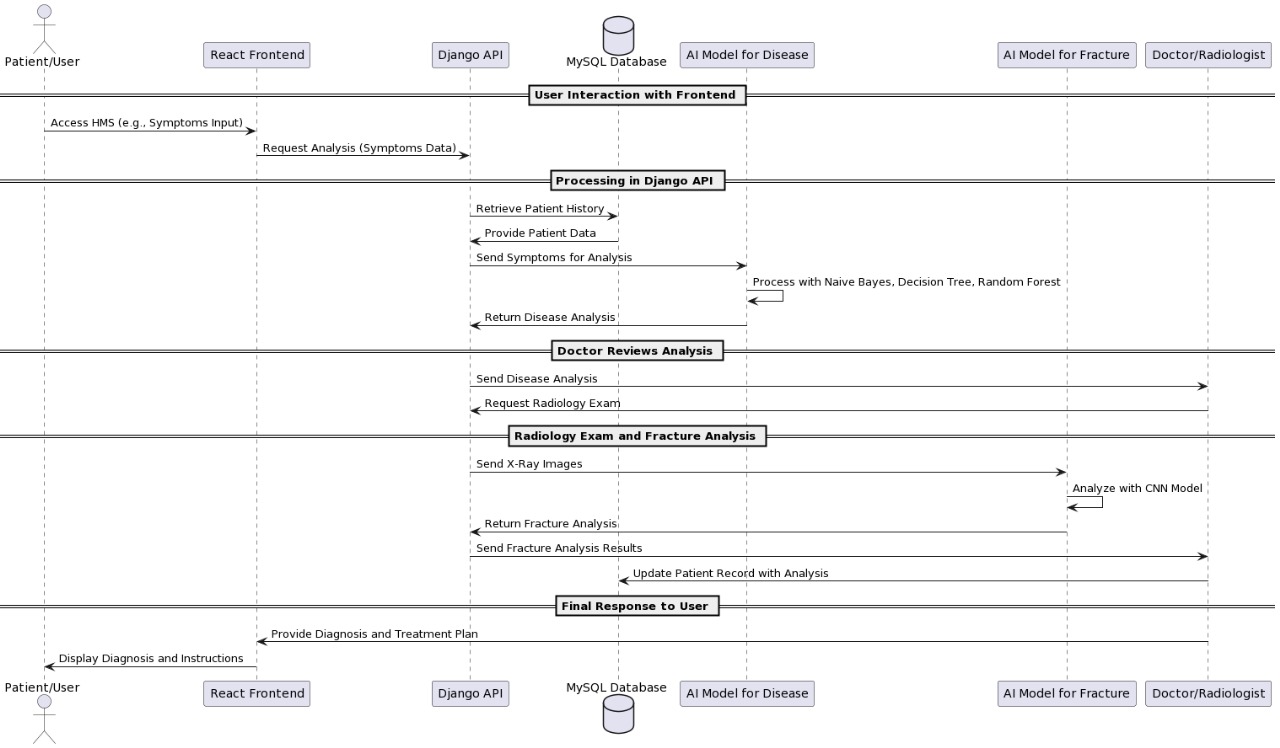


*Figure 5.2.4 Activity of Complete System*

## 5.3 Sequence Diagram

****

*Figure 5.3.1 Sequence of whole system*



*Figure 5.3.2 Sequence of Interaction among APIs and Model*

# Chapter 6

# AI-Model and Algorithms

## General Disease Detection:

We integrate the disease detection application that is primarily based at the system learning algorithm that is decision tree. We integrate this matching software for the assist of docs. Doctor will ask the signs and symptoms from patients and supply to that application a good way to are expecting the sickness from the given dataset.

A Decision Tree is a famous system gaining knowledge of set of rules used for classification and regression duties. Here is an in depth clarification of the way a selection tree works, including the important thing standards, steps, and attributes concerned in constructing and the use of a choice tree.

### Key Concepts of Decision Tree:

1. **Node**: Each point of decision in the tree.
   * **Root Node**: The topmost node, representing the entire dataset.
   * **Internal Node**: Nodes that represent decisions based on attributes.
   * **Leaf Node**: Terminal nodes that represent the output of the decision.
2. **Edge**: Connects nodes, representing the outcome of a decision.
3. **Attribute/Feature**: A characteristic of the data used to split the nodes.
4. **Gini Index / Entropy**: Measures used to determine the quality of a split. Lower values indicate a better split.
   * **Gini Index**: Measures the impurity of a dataset. Used in CART (Classification and Regression Trees).
   * **Entropy**: Used in ID3 and C4.5 algorithms to measure the disorder in the dataset.

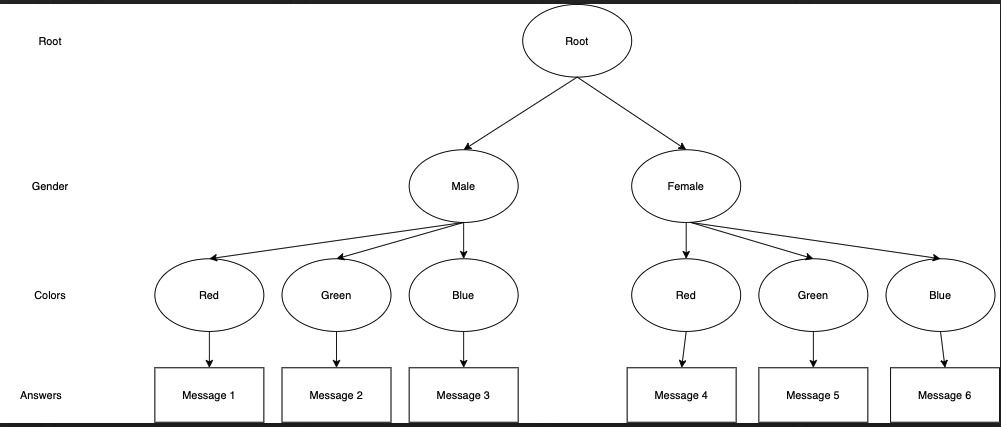
### Steps in Building a Decision Tree

1. **Selecting the Best Attribute**:
   * The process begins at the root node. The algorithm evaluates all possible features and selects the one that best splits the data into subsets with the most homogeneous target variable (class label).
   * This selection is based on the impurity measures such as Gini Index, Entropy, or Information Gain.
2. **Splitting the Dataset**:
   * Once the best attribute is selected, the dataset is split into subsets. Each subset corresponds to a unique value or range of values of the selected attribute.
3. **Creating Sub-nodes**:
   * Each subset created from the split becomes a new node in the tree. This node will be further split using the same process recursively.
4. **Stopping Criteria**:
   * The splitting process stops when one of the following criteria is met:
     + All the data in the node belongs to a single class.
     + There are no remaining attributes to split the data.
     + A predefined stopping condition such as maximum depth of the tree or minimum number of samples per node is reached.
5. **Pruning**:
   * Pruning is done to improve the tree's generalization ability by reducing its size. It removes branches that have little importance and can lead to overfitting.
   * **Pre-pruning**: Stops the tree growth early.
   * **Post-pruning**: Removes branches from a fully grown tree.

### Training Epochs

During an epoch, the learning algorithms updates the model’s parameters based on data. It took approximately 80 epochs to train.

### Architecture



*Figure 6.1.4.1 Architecture Diagram of Decision Tree*

### Confusion Matrix

*Figure 6.1.5.1 Confusion Matrix of G.D.D*

|  |  |  |
| --- | --- | --- |
|  | Predicted Positive | Predicted Negative |
| Actual Positive | 700 | 40 |
| Actual Negative | 60 | 635 |

Accuracy = (700 + 635) / (700 + 635 + 60 + 40)

Accuracy = 0.89

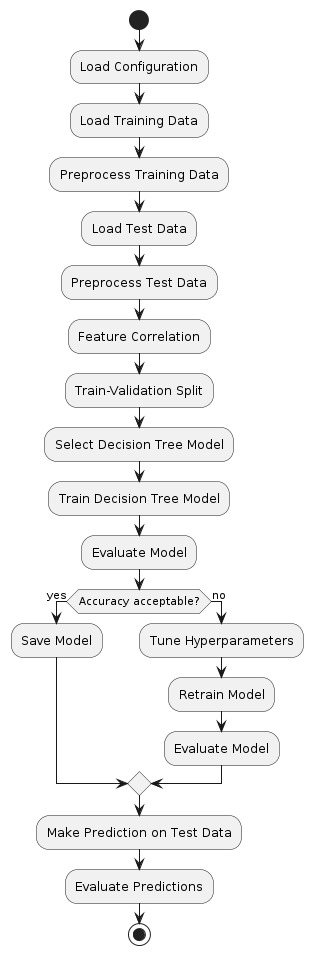
Accuracy = 0.89 x 100

Accuracy = 89 %

### Accuracy

Model accuracy is 89 %.

### Activity diagram of program



*Figure 6.1.1 Activity diagram of program*

## Fractured Bone Detection:

We have additionally integrate AI model for detection of fractured bones of wrists. This is done with the help of YOLO set of rules this is used for the detection of objects. Doctor will give the X-Ray image as enter to the model then model will predict, it's far fractured or now not as output.

### Dataset

The [GRAZPEDWRI-DX](https://www.nature.com/articles/s41597-022-01328-z) is an open dataset containing 20327 annotated pediatric trauma wrist radiograph images of 6091 patients, treated at the Department for Pediatric Surgery of the University Hospital Graz between 2008 and 2018. Several pediatric radiologists annotated the images by placing bounding boxes to mark 9 different classes:

* boneanomaly (276 boxes),
* bonelesion (45 boxes),
* foreignbody (8 boxes),
* fracture (18090 boxes),
* metal (818 boxes),
* periostealreaction (3453 boxes),
* pronatorsign (567 boxes),
* softtissue (464 boxes),
* text (23722 boxes).

### YOLO Working and Explanation

YOLO (You Only Look Once) is an object detection algorithm that has gained significant popularity in the field of computer vision. It is both an algorithm and a model architecture designed for real-time object detection tasks. YOLO stands out for its speed and accuracy in detecting objects in images and videos.

1. **Algorithm/Model**: YOLO is both an algorithm and a model architecture. The YOLO algorithm applies a deep convolutional neural network (CNN) model to perform object detection tasks.
2. **Real-Time Object Detection**: YOLO is designed for actual-time item detection, that means it could system pictures or video frames swiftly and hit upon gadgets within them with excessive accuracy.
3. **Single Pass**: Unlike conventional object detection techniques that apply a sliding window approach or vicinity notion networks, YOLO takes a single bypass thru the enter photograph or frame and without delay predicts bounding packing containers and class probabilities for all items detected.

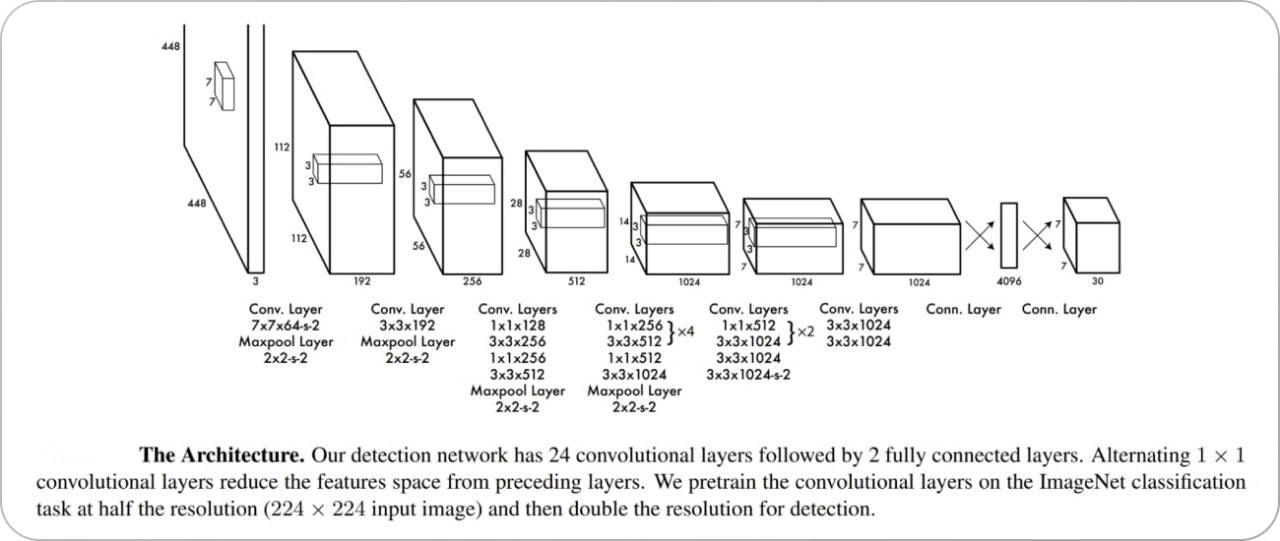
**YOLO Working**

1. **Grid-based Detection**:
   * YOLO divides the input image into a grid of cells. Each cellular is chargeable for predicting bounding boxes and sophistication possibilities for objects that fall inside it.
2. **Bounding Box Prediction**:
   * Each grid cell predicts multiple bounding containers (with predefined sizes and styles) along with self belief scores that imply the chance of each box containing an object.
3. **Class Prediction**:
   * Each bounding field predicts elegance chances for the items it incorporates. YOLO makes use of softmax activation to are expecting the opportunity distribution across more than one training.
4. **Non-Maximum Suppression (NMS)**:
   * YOLO applies non-maximum suppression to remove redundant or overlapping bounding boxes with decrease self belief rankings, retaining only the maximum assured detections.

### Training Epochs

During an epoch, the learning algorithms updates the model’s parameters based on data. It took approximately 120 epochs to train.

### Architecture Diagram:



*Figure 6.2.1 Architecture Diagram*

### Confusion Matrix:

*Figure 6.2.5.1 Confusion Matrix of Yolo Model*

|  |  |  |
| --- | --- | --- |
|  | Predicted Positive | Predicted Negative |
| Actual Positive | 2800 | 200 |
| Actual Negative | 300 | 2060 |

Accuracy = (2800 + 2060) / (2800 + 2060 + 300 + 200)

Accuracy = 0.81

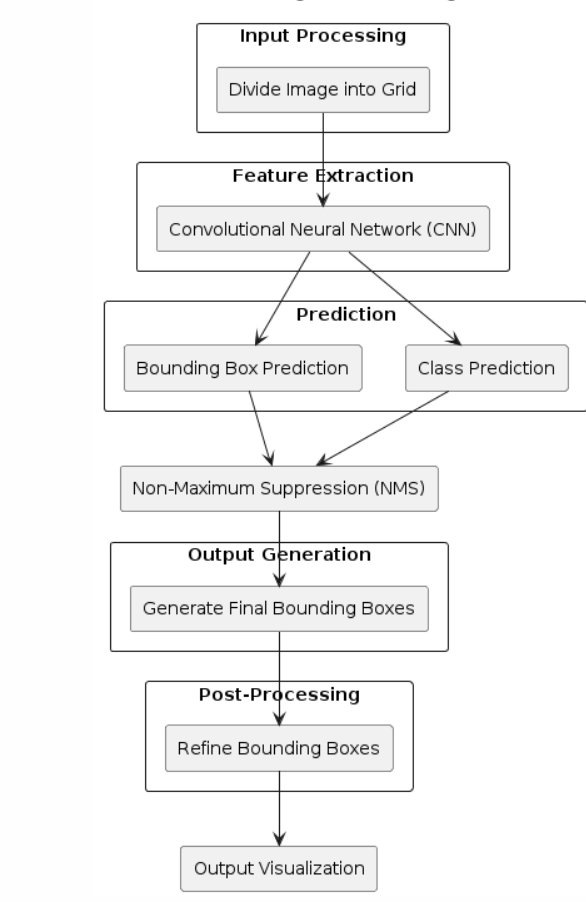
Accuracy = 0.81 x 100

Accuracy = 81 %

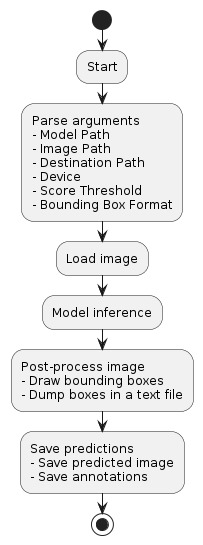
### Accuracy

Model Accuracy is 81%.

### Activity Diagrams



*Figure 6.2.2 Activity diagram of working of YOLO*



*Figure 6.2.3 Activity diagram of program*

# Chapter 7: System Implementation

After successfully completing the initial phases of development, including requirement analysis, design, and planning, we now proceed to the final stage: the actual implementation of the hospital management system. This chapter provides a comprehensive overview of the tools, technologies, and processes involved in the development of the system. We will detail each module and component, as well as the integration of an AI model for disease detection.

## 7.1 System Tools and Technology

The tools and technologies used in this project are as follows:

* **Django**: A high-level Python web framework that encourages rapid development and clean, pragmatic design.
* **React**: A JavaScript library for building user interfaces, particularly single-page applications.
* **MySQL**: An open-source relational database management system.
* **VS Code**: A source-code editor made by Microsoft with support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.
* **AI Model (Decision Tree)**: Used for disease detection based on user input.

### 7.1.1 Django

Django is a excessive-stage Python web framework that lets in fast improvement and clean, pragmatic layout. It takes care of much of the problem of net improvement, so developers can cognizance on writing their programs while not having to reinvent the wheel.

* **Routing**: Django's URL dispatcher allows clean, readable URLs.
* **Templating**: The Django template engine facilitates the separation of presentation and business logic.
* **ORM**: Django's Object-Relational Mapping (ORM) system makes it easy to interact with the database.
* **Security**: Django provides built-in protection against many security threats, including SQL injection, cross-site scripting, and cross-site request forgery.

### 7.1.2 React

React is a JavaScript library for building user interfaces. It enables developers to build complex UIs from small, isolated pieces of code called "components."

* **Component-Based**: React promotes the development of reusable components.
* **Virtual DOM**: React uses a virtual DOM to optimize rendering and improve performance.
* **JSX**: A syntax extension for JavaScript that looks similar to HTML, making it easier to write and understand components.

### 7.1.3 MySQL

MySQL is a widely used relational database management system. It is known for its reliability, high performance, and ease of use.

* **Data Storage**: MySQL stores data in tables, which are efficient for storing structured data.
* **Query Language**: MySQL uses Structured Query Language (SQL) for accessing and managing data.
* **Transactions**: MySQL supports transactions, ensuring data integrity and consistency.

### 7.1.4 VS Code

Visual Studio Code, commonly known as VS Code, is a source-code editor developed by Microsoft. It includes support for debugging, syntax highlighting, intelligent code completion, snippets, code refactoring, and embedded Git.

* **Extensions**: VS Code has a rich ecosystem of extensions that enhance its functionality.
* **Terminal**: The terminal allows running commands and scripts directly within the editor.
* **IntelliSense**: Provides smart completions based on variable types, function definitions, and imported modules.

## 7.2 Module Implementation

### 7.2.1 Dashboard

The Dashboard module provides an overview of the hospital's operations. It includes various sub-modules for different departments and functionalities.

***7.2.1.1 Front-Desk***

* Allows searching for patient records.
* Manages patient appointments.
* Displays the history of patient encounters.
* Allows uploading patient-related documents.
* Tracks the number of patient encounters.
* Generates reports on patient registrations.
* Provides reports on ward activities.
* Generates reports on patient encounters.

***7.2.1.2 Nursing***

* Records patient vital signs.
* Manages injection administration.
* Handles dressing and medical procedures.
* Manages immunization records.
* Manages antenatal clinic activities.
* Handles requisitions for medical supplies.
* Manages nursing inventory.
* Manages patient admissions.
* Generates reports on antenatal care.
* Provides reports on pregnancy cases.

***7.2.1.3 Doctors / Department***

* Manages outpatient department clinics.
* Handles patient admissions.
* Generates reports on patient encounters.
* Provides reports on patient diagnoses.

***7.2.1.4 Laboratory***

* Manages pending lab requests.
* Records lab results.
* Manages parameters for test reporting.
* Handles administration of lab tests.
* Manages categories of lab tests.
* Handles requisition of consumables.
* Manages lab inventory.
* Tracks the count of lab tests.
* Records lab test results.

***7.2.1.5 Radiology***

* Manages pending X-ray requests.
* Manages pending CT scan requests.
* Manages pending ultrasound requests.
* Manages pending ECG requests.
* Records radiology test results.
* Manages parameters for radiology test reporting.
* Handles administration of radiology tests.
* Tracks the count of radiology tests.

***7.2.1.6* *Dispensary***

* Manages outpatient dispensary.
* Manages inpatient dispensary.
* Handles purchase orders.
* Manages requisition for drugs and supplies.
* Manages dispensary inventory.
* Generates reports on dispensary activities.
* Manages the pharmacy store.
* Handles management of drugs.
* Manages consumables inventory.
* Manages store operations.
* Manages vendor information.
* Handles drug purchases.
* Confirms receipt of purchased drugs.
* Generates reports on drug expiry.
* Manages overall inventory.
* Manages consumables inventory.
* Confirms purchases.

***7.2.1.7* *HMO Authorization***

* Manages pending authorizations.
* Generates approval reports.
* Provides summaries of bills.
* Generates payment reports.
* Manages patient bills.
* Manages company-related information.
* Reviews patient bills.
* Generates patient bill reports.
* Manages admissions and discharges.
* Manages hospital services.

***7.2.1.8* *Cashier***

* Manages cashier activities.
* Handles deposits.
* Manages expenses.
* Generates daily cashier reports.
* Provides revenue reports.
* Generates payment reports.

***7.2.1.9* *Reports***

* Generates lab result reports.
* Provides appointment reports.
* Generates diagnosis reports.
* Manages drug inventory reports.
* Manages consumable inventory reports.
* Generates reports on admissions and discharges.
* Tracks patient SMS history.
* Provides payment reports.
* Generates encounter reports.
* Provides dispensary reports.
* Generates revenue reports.
* Manages ward reports.
* Provides antenatal care reports.
* Generates pregnancy reports.
* Tracks birth reports.
* Manages immunization reports.
* Tracks patient encounter count.
* Tracks laboratory test count.
* Tracks radiology test count.
* Provides registration reports.
* Manages expense reports.
* Confirms purchase reports.
* Tracks user login logs.

***7.2.1.10* *User Management***

* Manages vaccine information.
* Handles ward management.
* Manages bed availability.
* Manages user accounts.
* Controls user access permissions.
* Configures patient information.
* Manages patient discharge.
* Handles admissions and discharges.
* Manages admissions.
* Handles database backups.

***7.2.1.11* *SMS***

* Composes SMS messages.
* Tracks SMS history.
* Manages SMS settings.
* Generates SMS reports.

***7.2.1.12* *Administration***

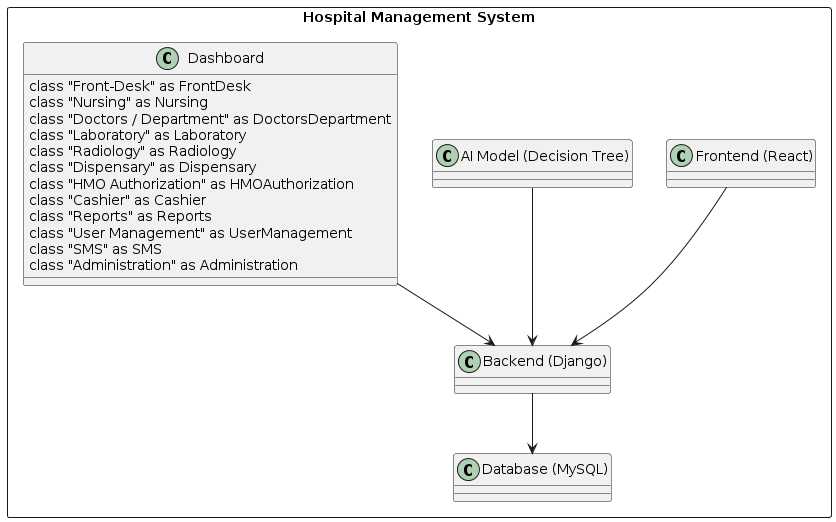
* Manages administrative activities.
* Configures encounter settings.
* Handles database backups.
* Manages antenatal care settings.

## 7.3 System Integration and Deployment

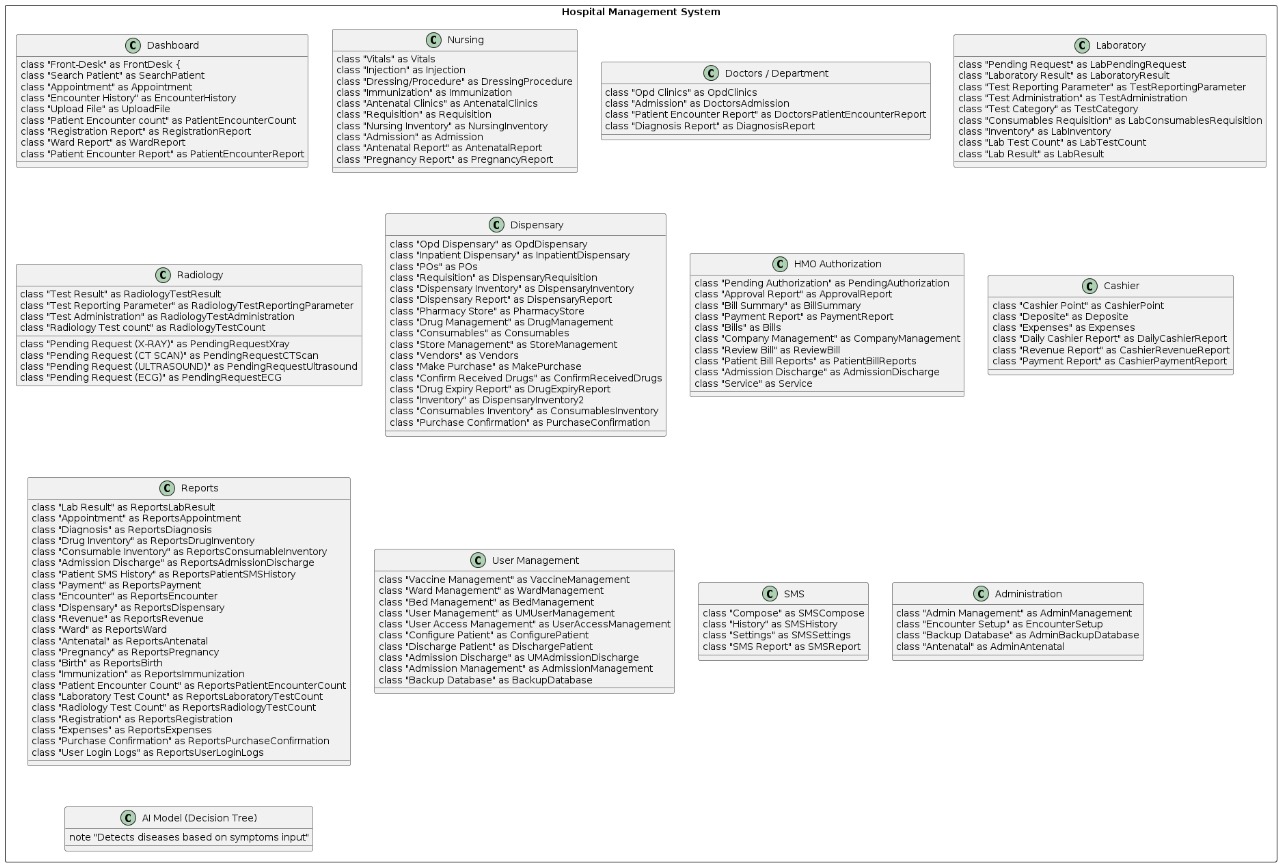
The health center management system is built the usage of Django for the backend, React for the frontend, and MySQL for the database. The integration of those technology ensures a seamless and efficient workflow.

### 7.3.1 Frontend-Backend Communication

React additives speak with the Django backend thru RESTful APIs. These APIs cope with diverse requests inclusive of fetching patient data, updating records, and processing bills.



*Figure 7.3.1.1 Class Diagram of Hospital Management System*



*Figure 7.3.1.2 Component Diagram of System*

### 7.3.2 Database Management

MySQL is used to save all the records related to the health facility's operations. Django's ORM makes it smooth to have interaction with the database, ensuring information integrity and consistency.

### 7.3.3 Deployment

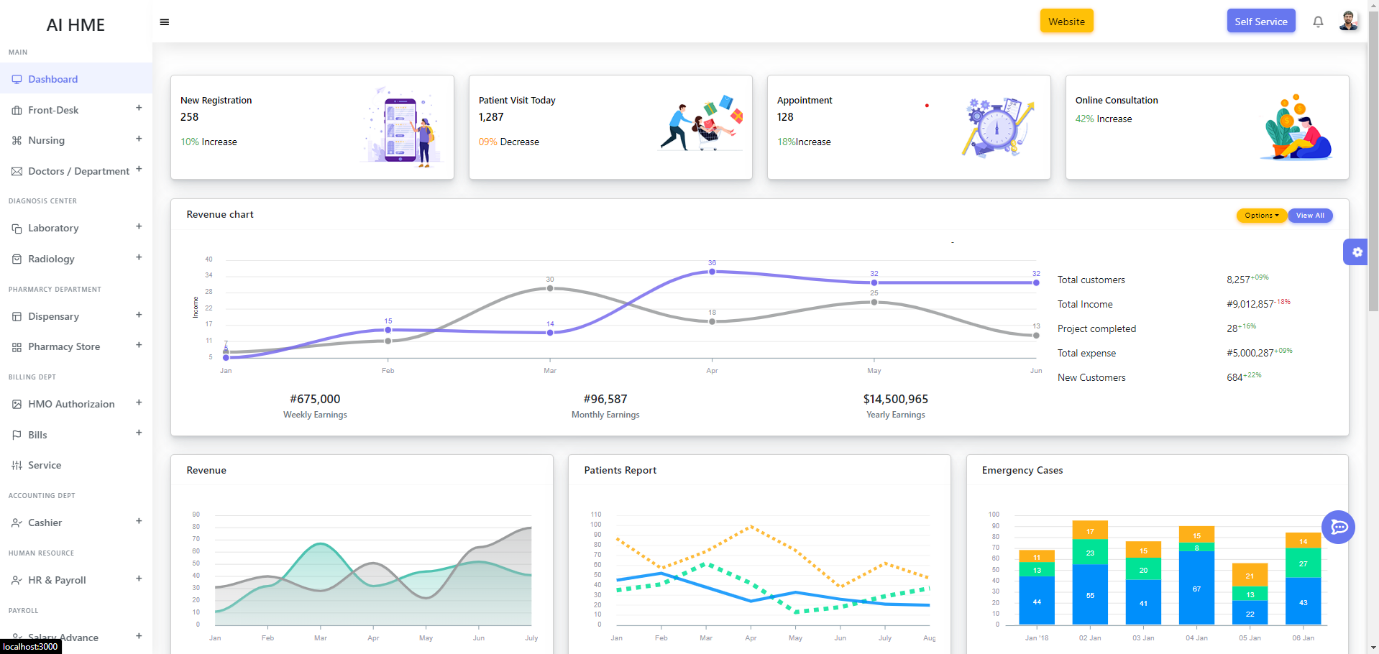
The system is deployed on a cloud platform, making sure excessive availability and scalability. Regular backups are taken to prevent statistics loss, and security features are carried out to shield touchy data.

**Conclusion**

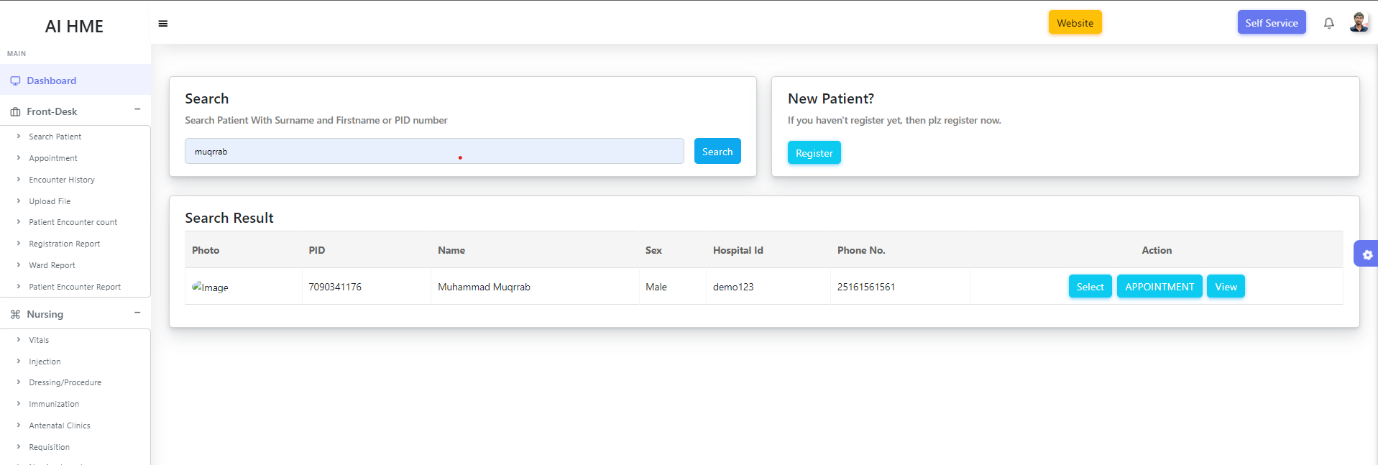
The implementation of the medical institution management machine entails the integration of numerous tools and technologies to create a complete answer for managing hospital operations. Each module and component is carefully designed and advanced to ensure a seamless and efficient workflow. The integration of an AI model for sickness detection adds a precious function to the device, supplying accurate and timely diagnoses primarily based on affected person input. This chapter provides an in depth assessment of the implementation method, highlighting the important thing components and capabilities of the machine.

# Chapter 8

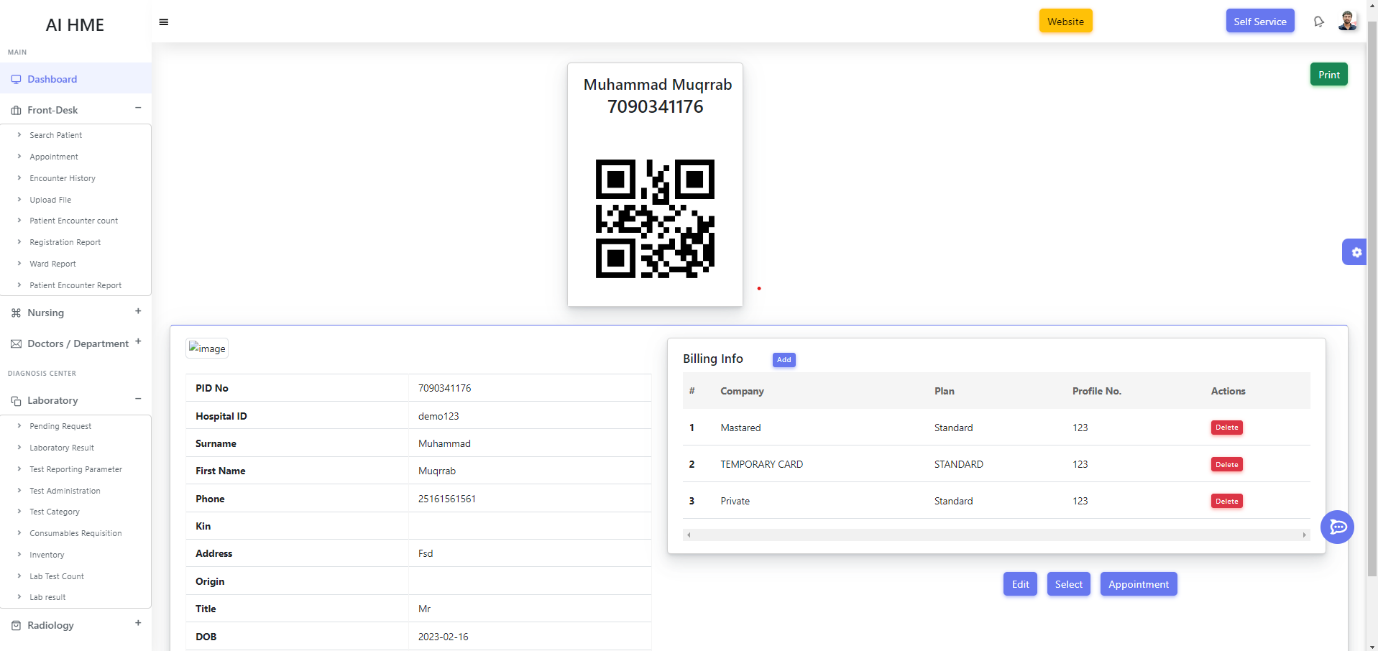
# 8 Screenshots



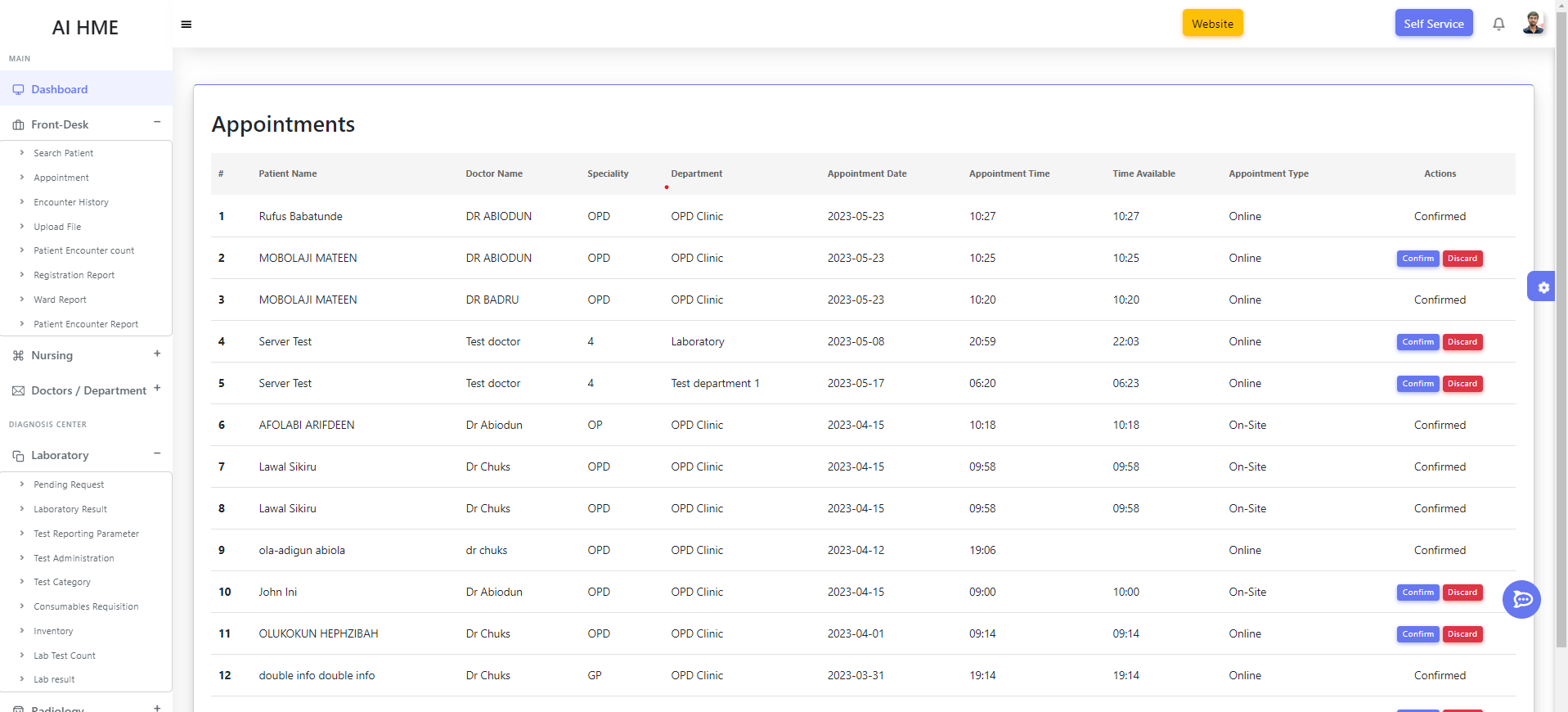
*Figure 8.1 Main Dashboard*



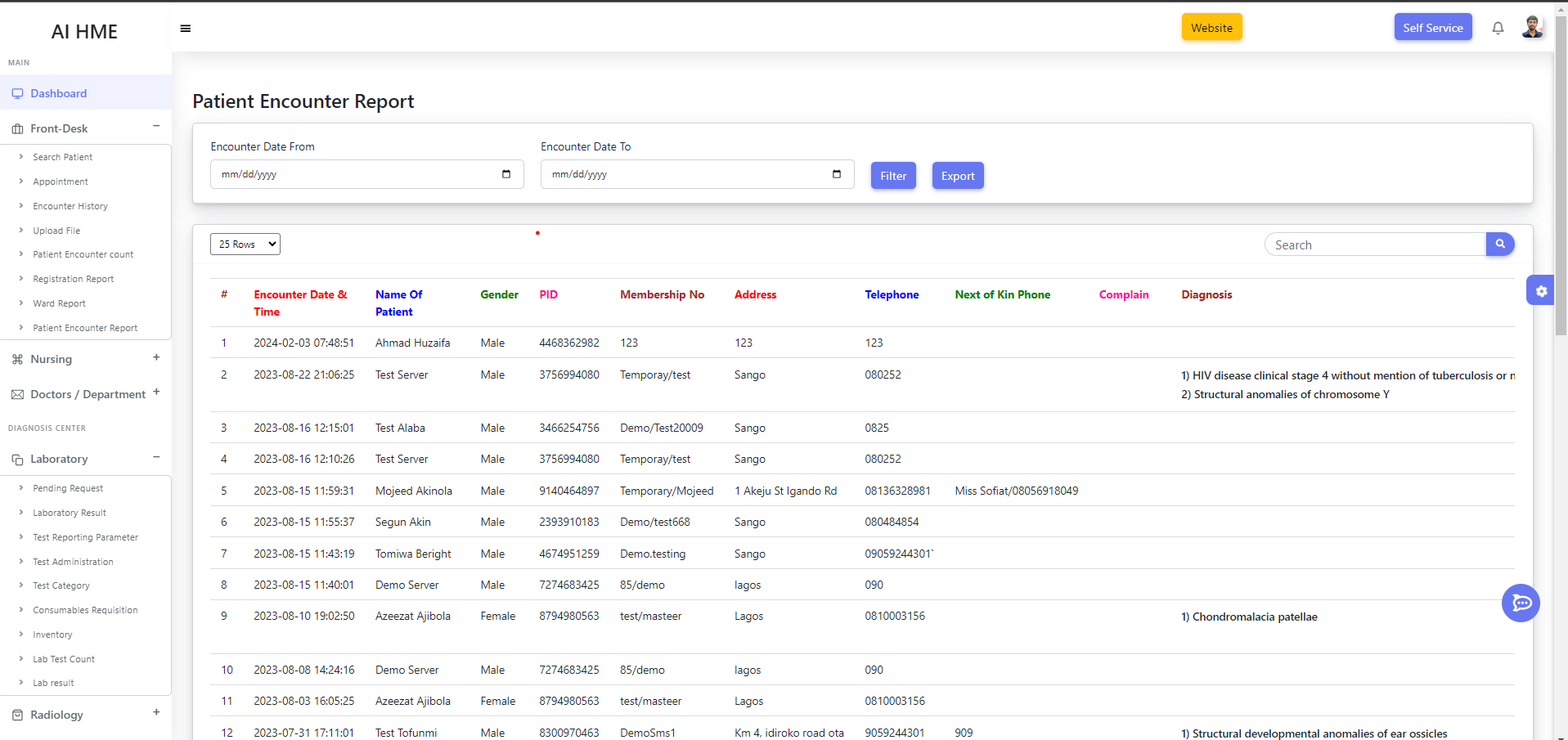
*Figure 8.2 Patient Dashboard*



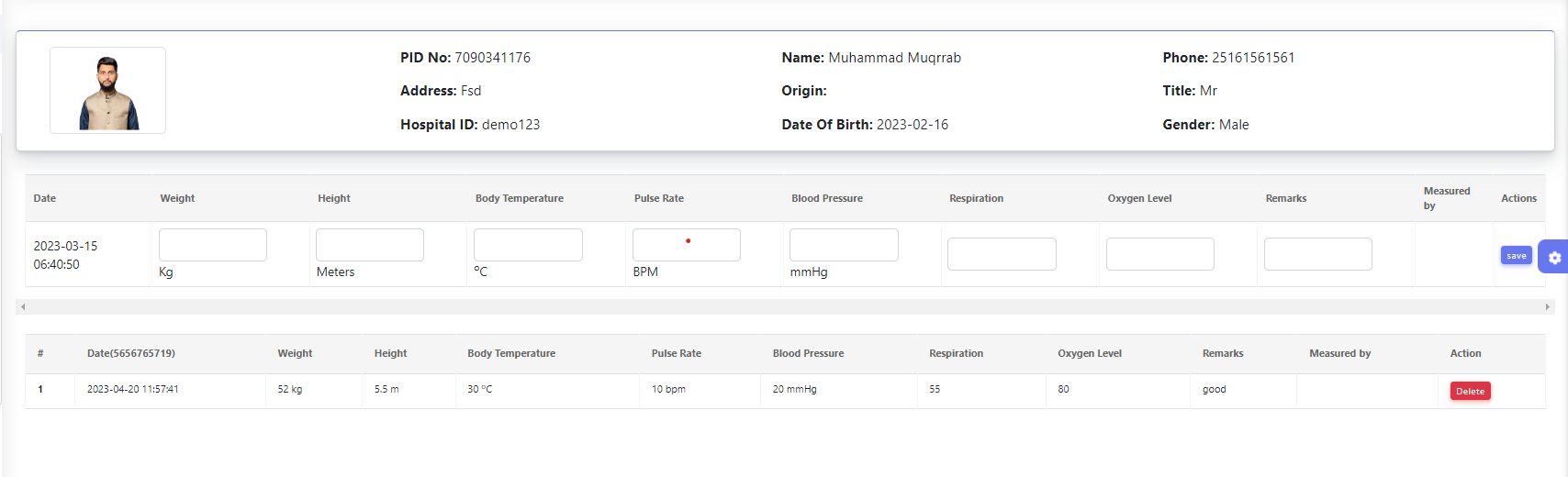
*Figure 8.3 Patient Detail*



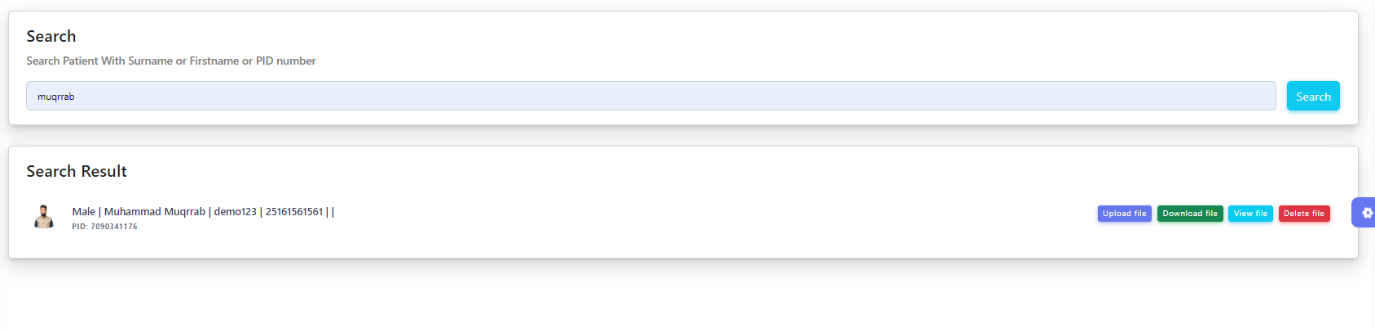
*Figure 8.4 Patient Appointment*



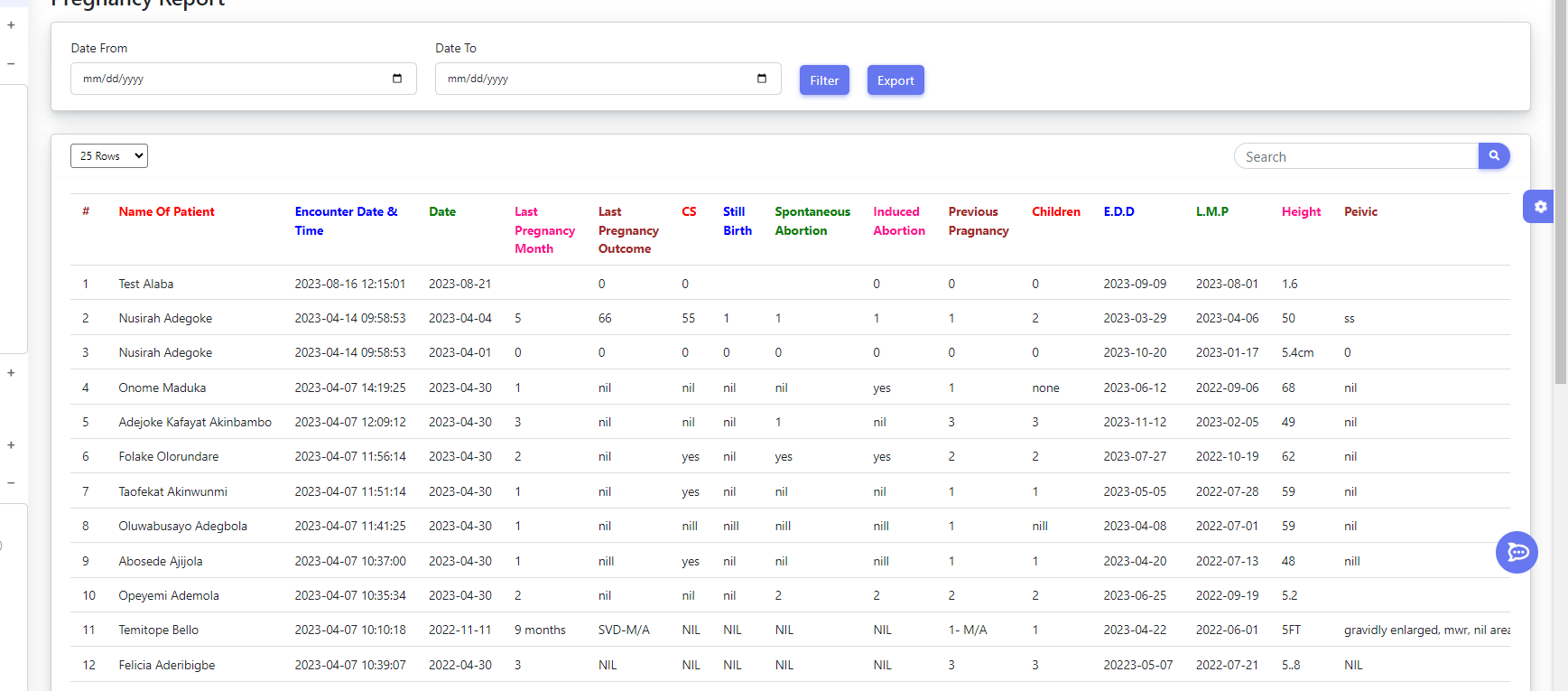
*Figure 8.5 Patient Report*



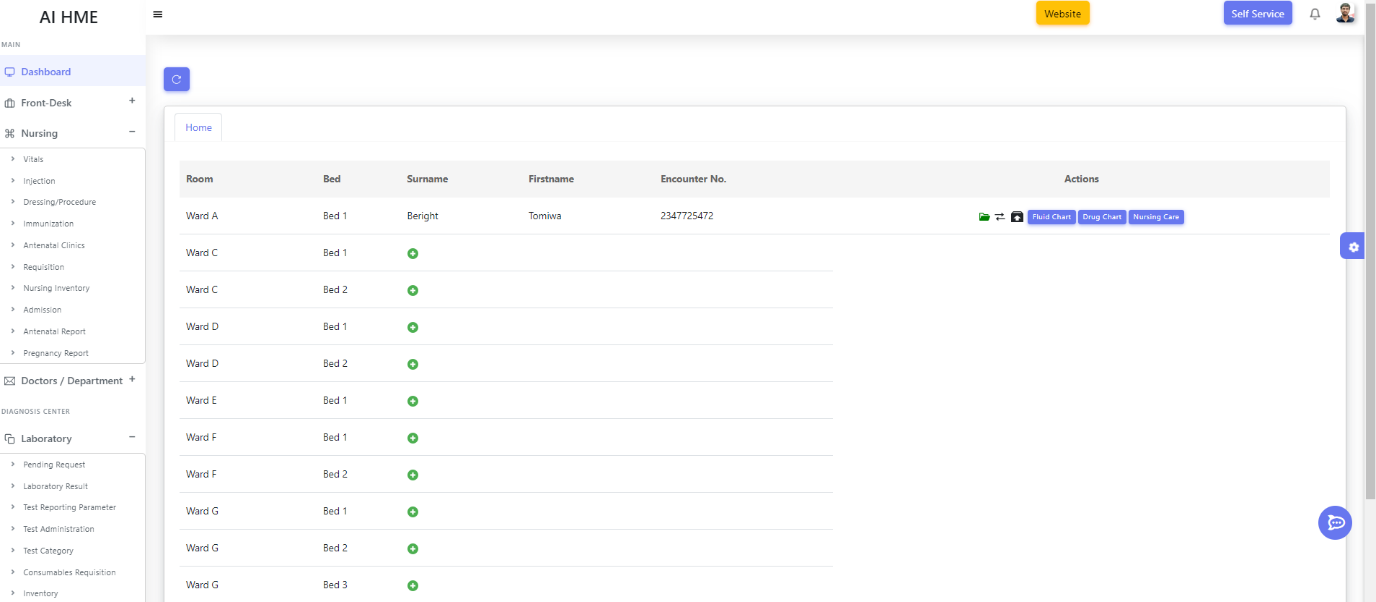
*Figure 8.6 Nurse Vital*



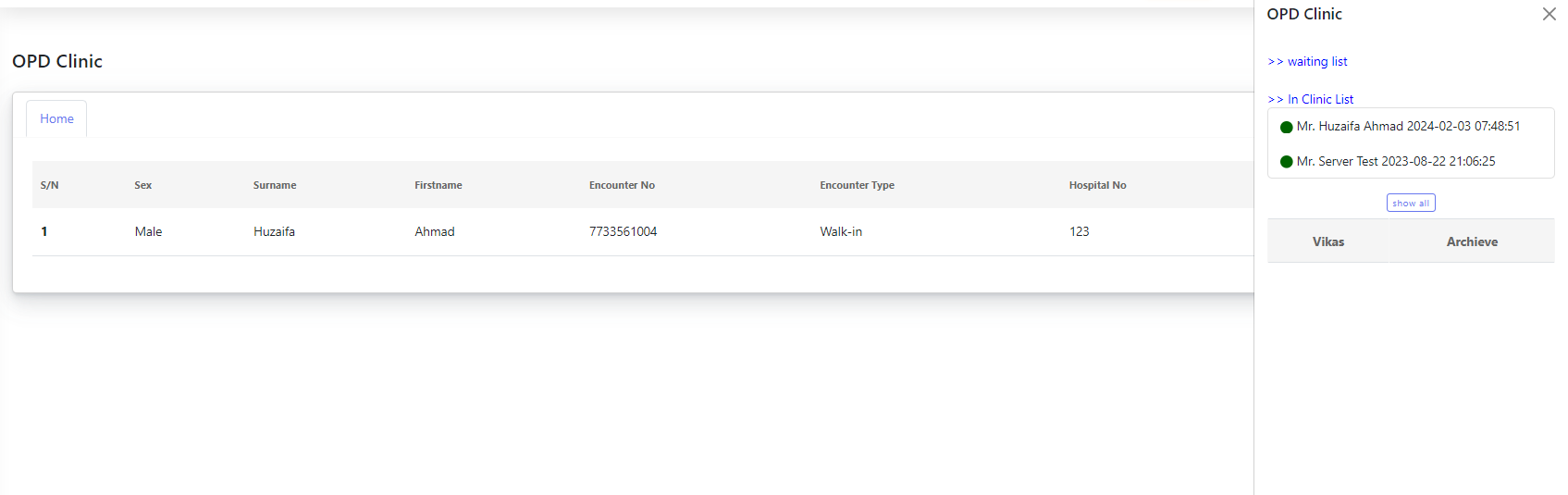
*Figure 8.7 Patient Data Update*



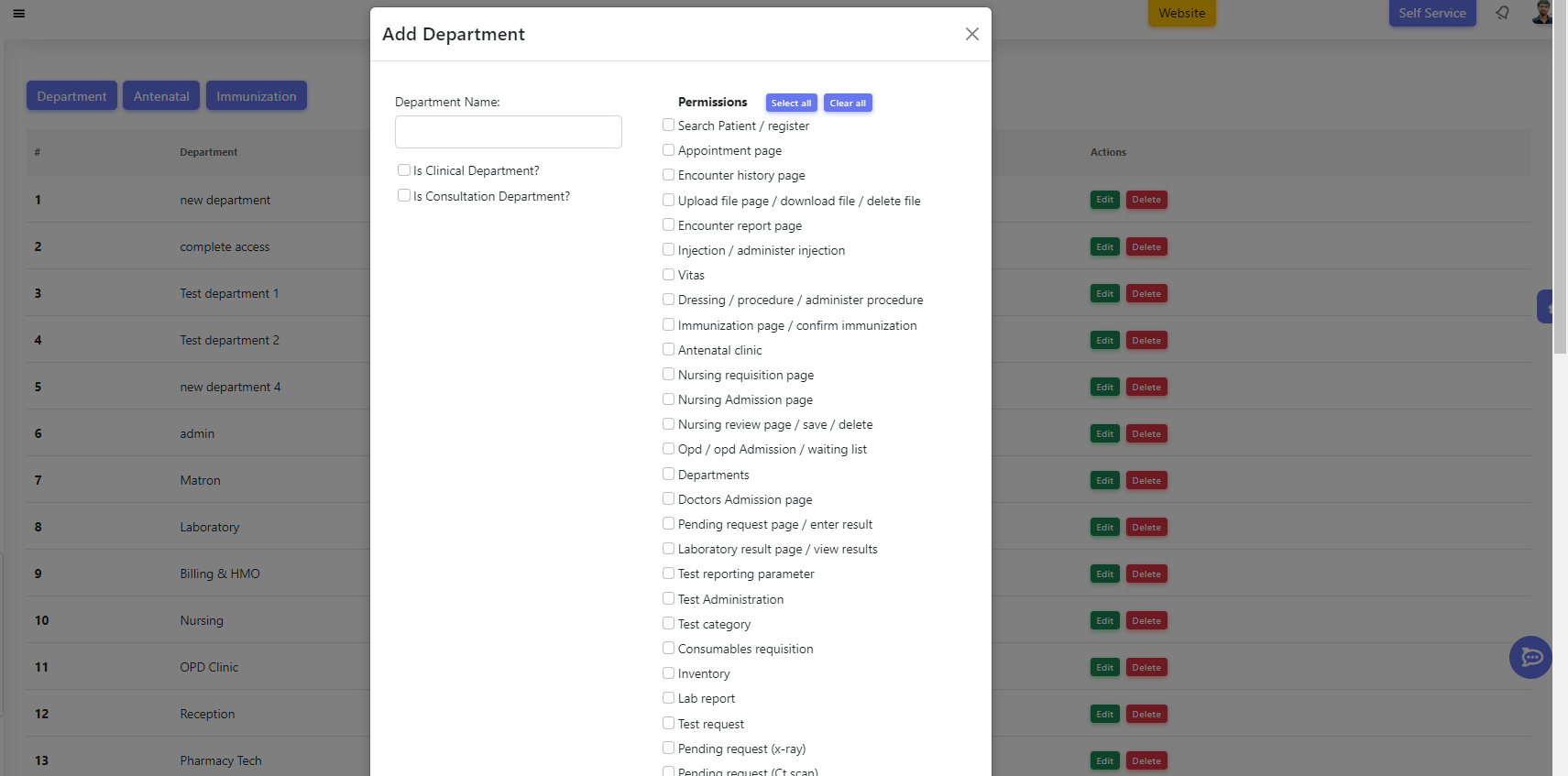
*Figure 8.8 Pregnancy Reports*



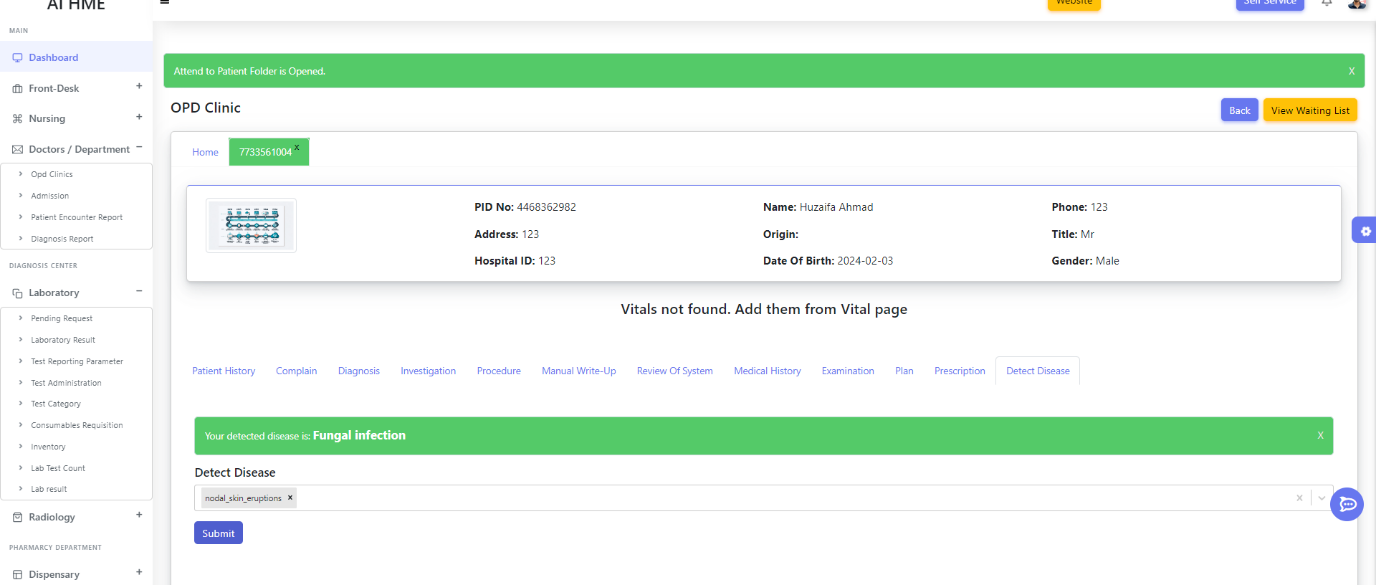
*Figure 8.9 Rooms and Bed Allocation*



*Figure 8.10 OPD Clinic*



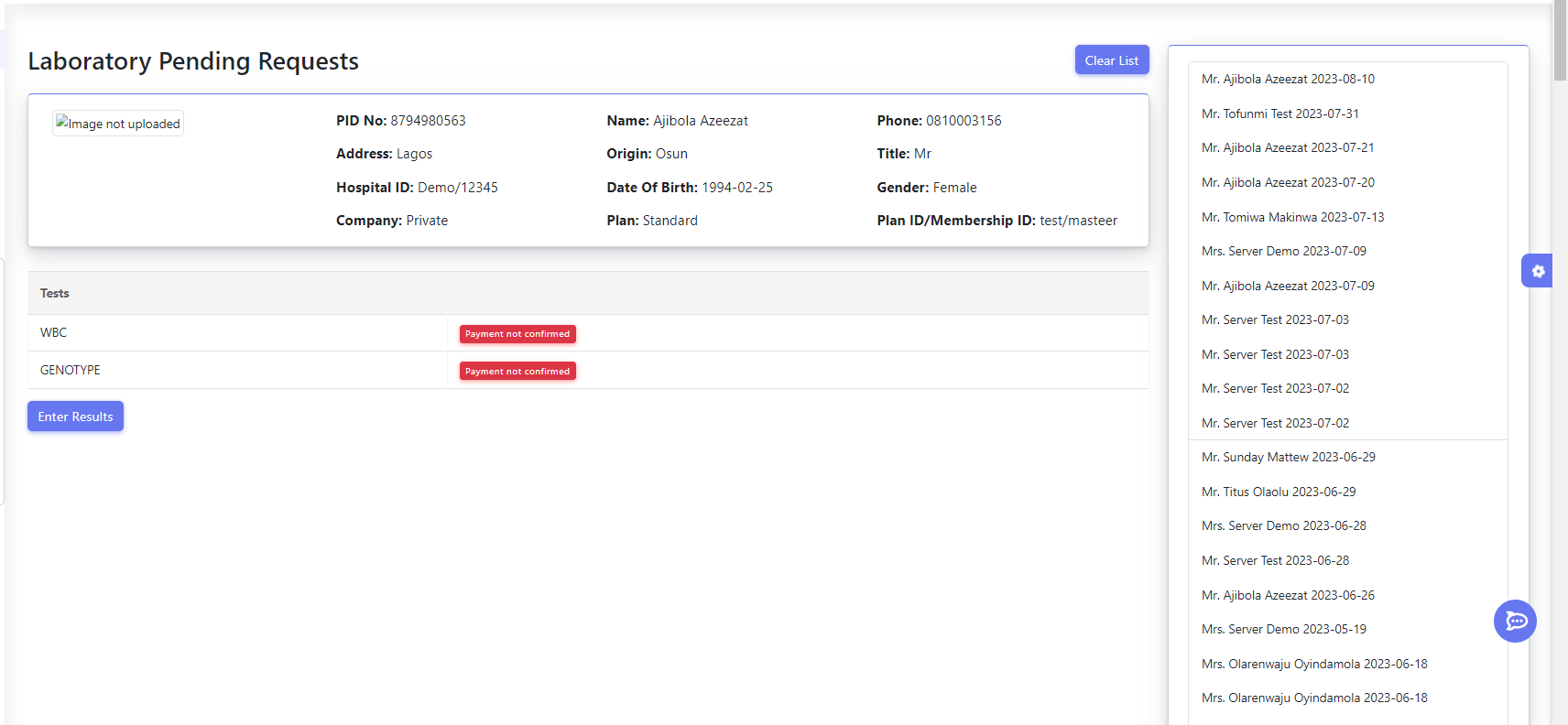
*Figure 8.11 Authorization*



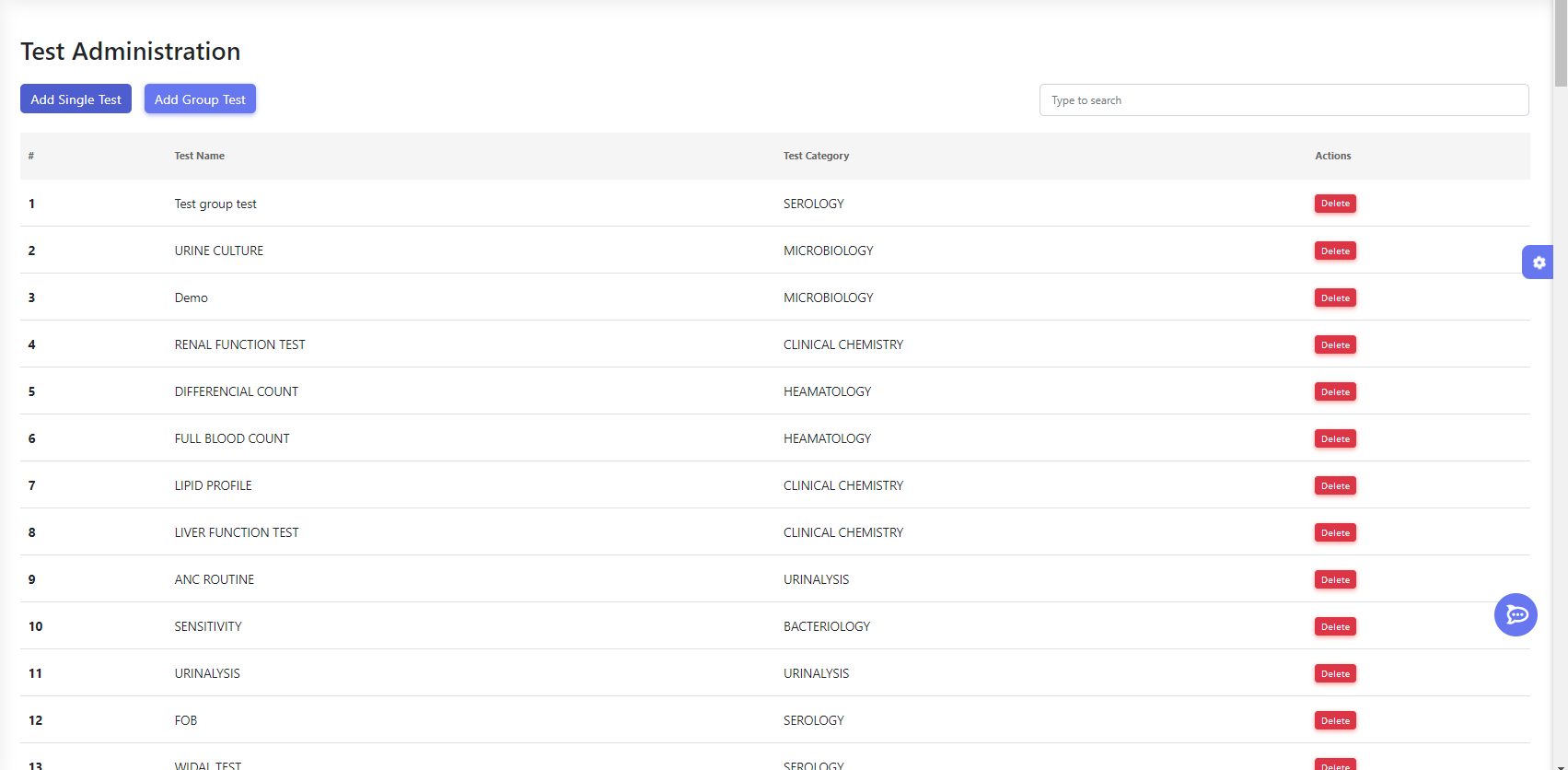
*Figure 8.12 General Disease AI Model*



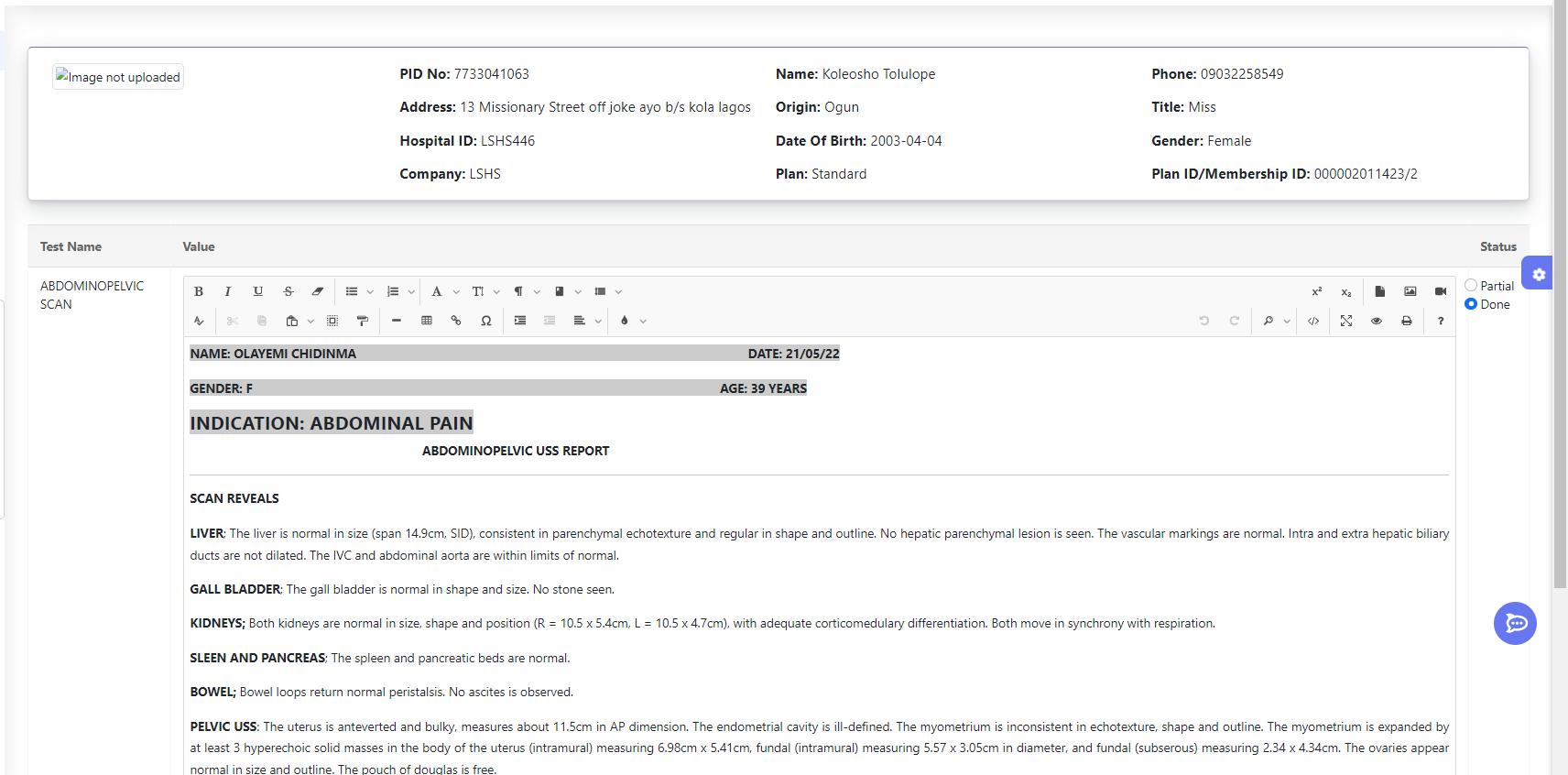
*Figure 8.13 Patient Vitals Details*



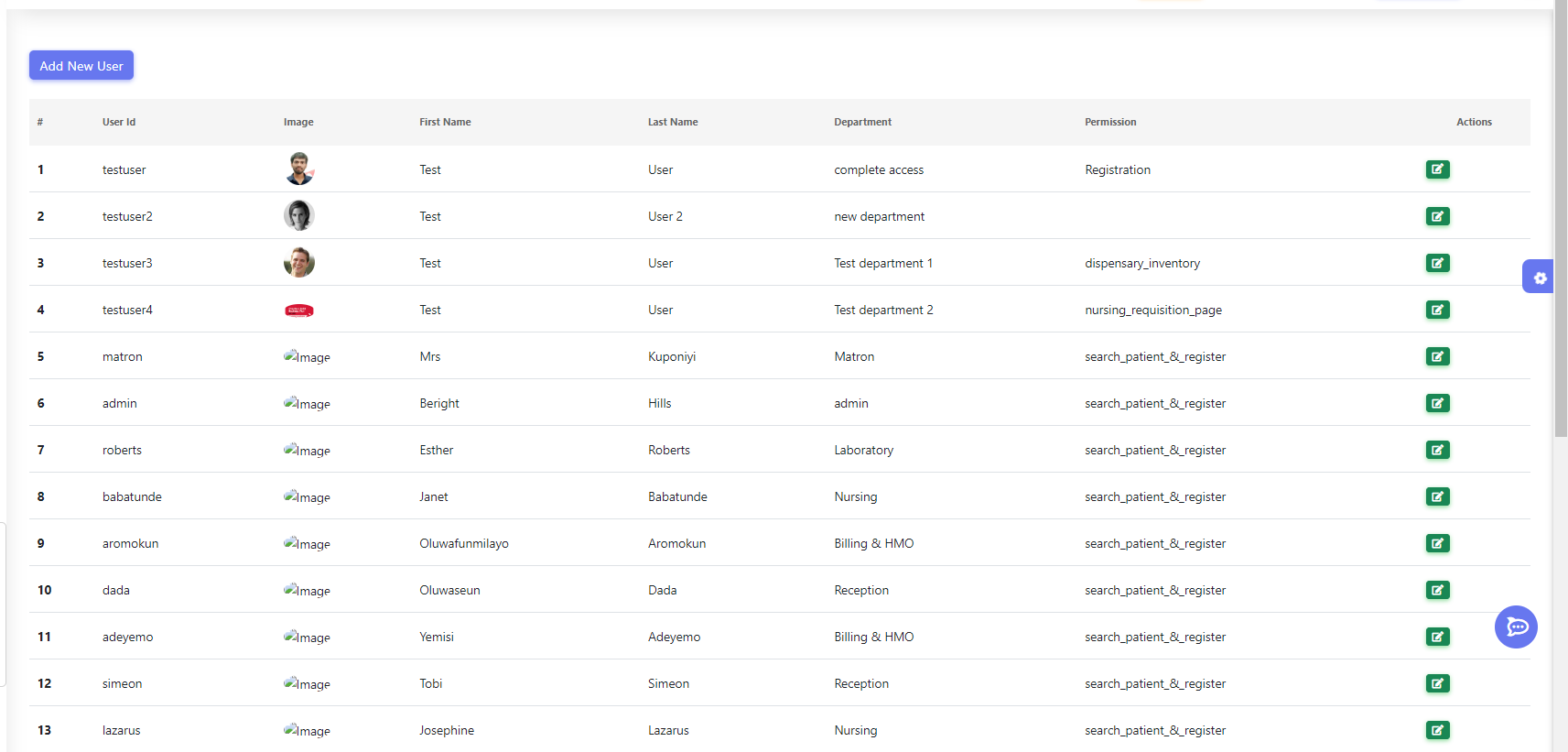
*Figure 8.14 Laboratory*



*Figure 8.15 Laboratory Tests*



*Figure 8.16 Laboratory Test Reports*



*Figure 8.17 User Management*

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