Safar

Project Team

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Chapter 1

Introduction

This document specifies the requirements for *Safar*, a tourism platform designed to improve travel planning and exploration for users interested in tourist destinations across Pakistan. The application offers features such as 3D-rendered environments, personalized trip planning, real-time chatbot assistance, and gamification elements like placing and collecting crystals at real-world locations.

The document is intended for various types of readers, each playing a critical role in the development and deployment of the application:

- **Developers**: To understand the technical architecture, functional requirements, and how everything connects.

- **Project Managers**: To oversee the project's scope, ensuring that everything stays on track and aligns with the overall vision.

- **End Users**: To gain insight into how the platform will meet their needs, particularly for planning trips, exploring destinations in 3D, and engaging in gamified experiences.

- **Testers**: To verify the functional and non-functional requirements as part of the testing process.

1.1   Problem Statement

Tourists in Pakistan frequently struggle to find reliable and engaging information about various tourist spots and navigate through local attractions. Existing platforms often fall short by lacking interactive and immersive experiences, which hinders their ability to engage users and sustain their interest. Key aspects of tourism, such as comprehensive

trip planning, curated itineraries, real-time assistance, and accurate navigation, are either missing or fragmented across multiple sources, making it difficult for users to take full advantage. This lack of up-to-date information often results in travelers being disappointed when destinations don't align with their expectations.

1.2   Scope

The scope of Safar includes an interactive web and mobile application that enhances travel planning for users interested in exploring destinations in Pakistan. The core functionality is to provide users with a virtual experience by using 3D scene of the destination created from 2D images. These images will go through 3D Gaussian splatting to create an immersive 3D scene. This feature will give users an ability to visualize and make a decision before they plan their trip.

Additionally, Safar allows users to create a personalized itinerary based on their budget, preference, and duration of stay. The itinerary provided will also allow users to further customize by considering their preference of activities or destination, suggesting the best possible itinerary for their trip.

Furthermore, inclusion of Gamification in our application allows user to earns points or rewards which will motivate users to engage more frequently (later on can be used to provide user with discounts or coupons). Safar will also be able to handle user queries on any of their upcoming trips or destination they are planning to visit using an AI-powered chat-bot.

1.3   Modules

Following are the modules involved in our final year project.

1.3.1   Web Application

The Safar web application is aimed at the users to interactively create, modify, and arrange their journeys. Additional possibilities are provided for trip arrangements, budget control, booking of the location and the accommodation as well as providing 3D views of the tourist attractions. As more advanced features content generation and web based communication with chat-bots are also applied resulting in customization and navigability of the content and feedback among the users improving both foreign and domestic tourism.

1. User Registration and Profile Management

2. Trip Planner

3. 3D Environment and Location Visualization

4. Real-Time Chatbot

5. User-Generated Content and Reviews

1.3.2 Mobile Application

Safar mobile application stands as a solution to the travelers where in one can plan, explore and handle their trips while they are on the move. Travelers can design their trips in full feature by planning for possible attractions to be visited in the country using the mobile application's capabilities such as customized itinerary, electric alerts, navigation and application of virtual reality technology to present prospective tourist sites before physical visit. Besides, the app helps them understand difficult procedures and provides real time communication with the client via interactive software for local and overseas users.

1. User Registration and Profile Management

2. Mobile Trip Planner

3. Real-Time Notifications and Updates

4. GPS and Offline Navigation

5. 3D Location Preview

6. Chatbot Integration

7. User Reviews and Photo Sharing

1.3.3 3D Scene Generator

The 3D Scene Generator module applies the use of innovative AI based systems in generating real-world 3D images of tourist sites and these are made available for users in a virtual way. If features for example rotating the view dynamically, changing the seasons, and rendering images of the location in very realistic manner are provided to the users they get to enjoy the locations.

1. AI-Powered 3D Scene Generation

2. Dynamic Seasonal and Time-based Changes

3. Interactive Exploration

4. Real-Time Rendering

5. Location-Based Accuracy

6. Low-Latency Performance

1.3.4 Chat-Bot

The module of Chatbot offers users instant, AI-based assistance by delivering immediate responses and tailored suggestions as they plan a trip.

1. Interactive Travel Assistance

2. Natural Language Processing (NLP)

3. Integration with Trip Planner

4. 24/7 Availability

5. User Feedback and Query Handling

1.3.5 Trip Planner

Trip Planner is a feature-rich module to plan travel experiences, allow users create and customize itineraries according to their interest deciding itinerary type (favorites from available places) or budget.

1. Customized Itineraries

2. Budget Management

3. Accommodation Recommendations

1.3.6 Gamification

Users want to be more connected with the things they love, this module is all about providing an Interactive and fun travel experience! The app is designed such that users earn badges on unlocking destinations, completing itineraries or participating in location-based challenges.

1. Badges and Rewards

2. Challenges and Leader boards

3. Achievement Tracking

4. Social Sharing of Achievements

1.4   User Classes and Characteristics

Following are the user classes that will use this product, and their pertinent characteristics.

Table 1.1: User Classes and Their Descriptions

User class	Description
Traveler	A Traveler is a user who utilizes the platform to plan and organize trips to various destinations. There are several thousand potential Travelers, and most of them are tech-savvy, using either the web or mobile app to explore locations, create trip plans, and track or collect crystals. Travelers may range from occasional vacationers to frequent explorers who use the platform several times per week. Some users may also utilize the 3D environment to explore destinations before physically visiting them.
Admin	An Admin is responsible for managing content on the platform, including adding or removing tourist locations, monitoring user-generated content (such as reviews or photos), and ensuring the accuracy of 3D environments and itineraries. Admins also handle user accounts, address any issues reported by Travelers, and manage the overall functionality of the application.

Chapter 2

Project Requirements

This chapter describes the functional and non-functional requirements of the project.

2.1 Use-cases

Following are prominent use cases for our system. Every use case is expressed in fully-dressed format.

2.1.1 Explore 3D Spaces

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants to explore tourist locations virtually to plan their trip.

Preconditions: User must have logged in and selected a location to explore. 3D data for the location must be available.
Success Guarantee: The user successfully navigates and explores the 3D environment.
Main Success Scenario:

1. User selects a tourist destination from the app.

2. System loads the 3D environment.

3. User navigates through the 3D space.

Extensions:

- **E1:** If 3D data is unavailable, the system suggests alternatives.

- **E2:** If the internet connection is unstable, the system shows a loading screen.

2.1.2 View Leaderboards

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants to see rankings based on activities like placing and collecting crystals.

- **Admin:** Interested in increasing engagement through gamification.

Preconditions: User must be logged in and have participated in app activities.
Success Guarantee: The leaderboard displays accurate rankings.
Main Success Scenario:

1. User navigates to the leaderboard section.

2. System retrieves the latest leaderboard data.

3. Leaderboard is displayed.

Extensions:

- **E1:** If no data is available, the system displays a message.

Special Requirements: Real-time leaderboard updates.
Technology and Data Variations List: Sorting methods for leaderboards (e.g., by region).

2.1.3 Place Crystals

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants to place a crystal at a real-world location to signify their visit.

- **Other Users:** Interested in seeing crystals placed by others as markers of visited locations.

Preconditions: User must be at a specific real-world location and logged into the app. The location must be within an area supported by the app for crystal placement.
Success Guarantee: A crystal is successfully placed at the real-world location and is visible in the 3D model.
Main Success Scenario:

1. User arrives at the specified real-world location.

2. User opens the app and selects the option to place a crystal.

3. The system validates that the user is at the correct location.

4. The user confirms the placement, and the crystal is added to the 3D environment as a marker of the visit.

Extensions:

- **E1:** If the user is not at a valid location, the system prompts the user with an error message.

- **E2:** If the maximum number of crystals for that location is reached, the system notifies the user.

Special Requirements: Location-based services must be accurate for crystal placement.
Technology and Data Variations List: Support for GPS data accuracy for location verification.

2.1.4 Collect Crystals

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants to collect crystals at specific real-world locations to earn rewards and enhance their profile.

- **App developers:** Interested in gamifying the experience to increase user engagement.

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Preconditions: User must be physically present at the location where a crystal is placed and logged into the app. Crystals must be available for collection at that location.
Success Guarantee: The crystal is successfully collected, and the user's score is updated.
Main Success Scenario:

1. User arrives at the specified location where a crystal is placed.

2. User opens the app and selects the option to collect the crystal.

3. The system verifies that the user is at the correct location.

4. The user confirms the collection, and the crystal is removed from the 3D environment, updating their score and profile.

Extensions:

- **E1:** If the user is not at the crystal's location, the system notifies the user and prevents the collection.

- **E2:** If the crystal has already been collected by another user, the system informs the user.

Special Requirements: Immediate feedback upon successful collection.
Technology and Data Variations List: Different methods for users to interact with the collection feature (e.g., tap, click).

2.1.5   Modify Itinerary

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants to modify their trip plan based on preferences or changes.

Preconditions: The system has already created an itinerary.
Success Guarantee: The itinerary is successfully updated.
Main Success Scenario:

1. User opens the itinerary.

2. System displays the existing itinerary.

3. User modifies the itinerary and saves the changes.

Extensions:

- **E1:** If a location is unavailable, the system suggests alternatives.

Special Requirements: Real-time updates of location availability.

2.1.6   Interact with Chatbot

Scope: Safar Tourism App
Level: User goal
Primary Actor: User
Stakeholders and Interests:

- **User:** Wants quick answers to questions about destinations, itineraries, or app usage.

Preconditions: The chatbot must be active and available.
Success Guarantee: The chatbot provides relevant and helpful responses.
Main Success Scenario:

1. User opens the chatbot and asks a question.

2. System processes the input and retrieves relevant information.

3. Chatbot provides the answer or suggestion.

Extensions:

- **E1:** If the chatbot cannot understand, it asks for clarification.

Special Requirements: Natural language processing (NLP) for smooth interaction.

2.1.7   Manage Users

Scope: Safar Tourism App
Level: Subfunction
Primary Actor: Admin
Stakeholders and Interests:

- **Admin:** Wants to manage user accounts to ensure a secure environment.

Preconditions: Admin must be logged in to the admin panel.
Success Guarantee: User accounts are successfully managed.
Main Success Scenario:

1. Admin logs into the dashboard and accesses "Manage Users."

2. Admin edits or deactivates accounts as necessary.

3. System updates the user information.

Extensions:

- **E1:** If an error occurs during the update, the system notifies the admin.

Special Requirements: Security measures to protect user data.
Technology and Data Variations List: Support for different user roles and permissions.

2.1.8 Manage 3D Spaces

Scope: Safar Tourism App
Level: Subfunction
Primary Actor: Admin
Stakeholders and Interests:

- **Admin:** Wants to manage and update 3D spaces for accuracy.

Preconditions: Admin must be logged in to the admin panel.
Success Guarantee: 3D spaces are updated or managed successfully.
Main Success Scenario:

1. Admin accesses "Manage 3D Spaces."

2. Admin updates or deletes existing 3D environments.

3. System confirms the changes.

Extensions:

- **E1:** If the 3D data is corrupted, the system alerts the admin.

2.1.9   Manage Tourist Locations

Scope: Safar Tourism App
Level: Subfunction
Primary Actor: Admin
Stakeholders and Interests:

- **Admin:** Wants to ensure all tourist locations are up-to-date and accurate for users.

Preconditions: Admin must be logged in to the admin panel.
Success Guarantee: Tourist locations are updated or managed successfully.
Main Success Scenario:

1. Admin accesses "Manage Tourist Locations."

2. Admin adds, edits, or removes locations as necessary.

3. System confirms the changes.

Extensions:

- **E1:** If the location data is invalid, the system alerts the admin.

2.1.10   Generate Itinerary

Scope: Safar Tourism App
Level: Subfunction
Primary Actor: System
Stakeholders and Interests:

- **User:** Wants a personalized itinerary based on preferences.

- **Admin:** Interested in automating the itinerary creation process.

Preconditions: User inputs preferences for their trip.
Success Guarantee: A personalized itinerary is generated.
Main Success Scenario:

1. User inputs their trip preferences.

2. The system analyzes the input data.

3. The system generates a personalized itinerary for the user.

Extensions:

- **E1:** If no suitable locations are found, the system suggests popular alternatives.

Special Requirements: The itinerary must be generated quickly.

2.1.11   Manage Leaderboards

Scope: Safar Tourism App
Level: Subfunction
Primary Actor: System
Stakeholders and Interests:

- **User:** Wants to see updated leaderboard rankings.

- **Admin:** Interested in maintaining accurate leaderboard data.

Preconditions: User data and crystal collection data must be available.
Success Guarantee: Leaderboards are updated and displayed accurately.
Main Success Scenario:

1. User accesses the leaderboard.

2. The system retrieves and displays the latest data.

Extensions:

- **E1:** If data is unavailable, the system notifies the user.

Special Requirements: Real-time updates to the leaderboard.
Technology and Data Variations List: Different sorting methods (e.g., by region or activity).
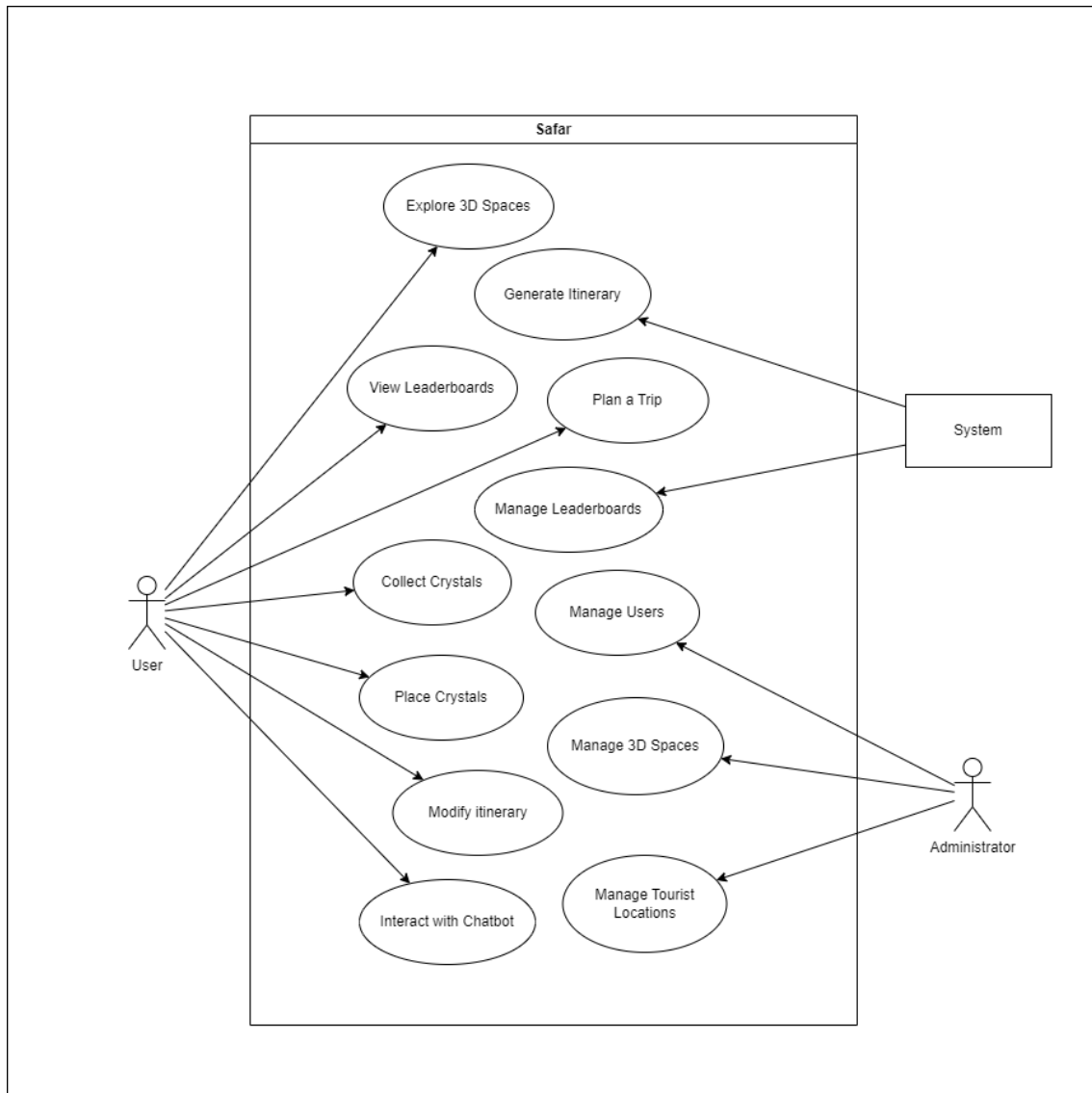
Figure 2.1: Use Case Diagram

2.2 Functional Requirements

2.2.1 Web Application Module

- **Feature 1.1: User Authentication**
  - Users can register and log in via the web interface using email and password.
  - Users can reset passwords through an email-based recovery process.

- **Feature 1.2: Dashboard**

- – Users can view their trips, explore locations, and manage their account from the dashboard.

- – Admins can log in and manage content (e.g., locations, user reviews).

- **Feature 1.3: Trip Plan Management**

  - – Users can create, edit, and delete trip plans.

- **Feature 1.4: Crystal Interaction**

  - – Users can see their collected crystals in their profile.

  - – Users can view crystals placed by others on the web-based 3D map.

  - – The system allows users to track which locations have crystals to collect.

2.2.2 Mobile App Module

- **Feature 2.1: GPS-Based Location Tracking**

  - – The mobile app uses GPS to track users' real-time location when visiting destinations.

- **Feature 2.2: Crystal Placement and Collection**

  - – Users can place crystals at physical locations after visiting them in person.

  - – The system verifies the user's presence at the location through GPS before allowing crystal placement.

  - – Users can collect crystals placed by others by physically being at the crystal's location.

- **Feature 2.3: Notifications**

  - – Users receive push notifications about upcoming trips, nearby crystals, and special offers related to tourism destinations.

- **Feature 2.4: Offline Mode**

  - – The mobile app supports limited offline functionality, allowing users to access saved trip plans and downloaded 3D environments.

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2.2.3 3D Scene Generator Module

- **Feature 3.1: 3D Environment Rendering**

  - The system generates 3D renderings of tourism spots using data from real-world images and GPS coordinates.

  - Users can explore locations in 3D, rotate the view, and zoom in or out to get a better perspective.

- **Feature 3.2: Crystal Visualization**

  - Crystals placed by users are rendered in the 3D environment at their real-world locations.

  - The system updates the 3D scene in real-time as crystals are placed or collected.

- **Feature 3.3: Integration with Trip Planner**

  - The 3D module integrates with the trip planner to visualize selected destinations and routes within the 3D environment.

2.2.4 Chatbot Module

- **Feature 4.1: User Assistance**

  - The chatbot provides assistance to users by answering questions about locations, trip planning, and app functionality.

  - Users can ask the chatbot for recommended destinations based on their preferences.

- **Feature 4.2: Trip Planning Guidance**

  - The chatbot helps users create trip plans by suggesting destinations, travel routes, and activities based on user inputs.

- **Feature 4.3: Integration with FAQs**

  - The chatbot is integrated with a FAQ database to provide users with answers to common questions about the app.

2.2.5   Trip Planner Module

- **Feature 5.1: Trip Creation**

    - Users can create custom trip plans by selecting locations, dates, and preferred activities.

    - The system provides suggestions for nearby attractions and recommended routes.

- **Feature 5.2: Itinerary Generation**

    - The system generates suggested itineraries based on the selected destinations and time constraints.

    - Users can edit the generated itinerary by adding or removing stops.

- **Feature 5.3: Travel Time and Distance Calculation**

    - The trip planner calculates estimated travel times and distances between destinations.

- **Feature 5.4: Trip Saving**

    - Users can save trip plans for future use.

- **Feature 5.5: Integration with Maps**

    - The trip planner integrates with Google Maps (or a similar service) to provide users with directions and navigation support.

2.3   Non-Functional Requirements

This section specifies the non-functional requirements of the "Safar" app. These requirements define the quality attributes the system must meet.

2.3.1   Reliability

The system should work consistently and minimize errors.

- **REL-1:** The app should run for at least 1000 hours without breaking down.

- **REL-2:** If an error occurs, the system should log it immediately and notify the team.

- **REL-3:** In the event of failure, the system should restore user data within 5 minutes, ensuring no data loss.

2.3.2 Usability

The app should be easy to use and accessible to all users.

- **USE-1:** After logging in, users should be able to explore a 3D location with no more than three taps or clicks.

- **USE-2:** A tutorial should be available on first use to guide users through key features.

- **USE-3:** The app should function well on different screen sizes, including mobile and tablets.

- **USE-4:** Users should be able to retrieve their last planned trip with a single tap from the main screen.

2.3.3 Performance

The app must respond quickly and handle many users at the same time.

- **PER-1:** 95% of the app's pages should load within 3 seconds on a 10 Mbps internet connection.

- **PER-2:** The 3D spaces should load and become interactive within 5 seconds of selection.

- **PER-3:** The app should support up to 1000 users at once without major slowdowns.

- **PER-4:** Trip planning and saving actions should complete within 2 seconds on average.

2.3.4 Security

The app should protect user information from unauthorized access.

- **SEC-1:** All user data, including account details and trip plans, should be encrypted with 256-bit AES encryption.

- **SEC-2:** Admin accounts should use two-factor authentication for added security.

- **SEC-3:** After 5 failed login attempts within 10 minutes, the system should lock the account and allow reset only via email.

- **SEC-4:** All user and admin actions should be logged and stored securely for at least 1 months.

2.3.5 Availability

The system should be accessible to users at all times.

- **AVA-1:** The app should be available 99.9% of the time, allowing only minimum amount of downtime.

- **AVA-2:** Planned maintenance or updates should notify users at least 24 hours before downtime.

2.3.6 Scalability

The app should handle increased demand as more users join.

- **SCA-1:** The system should be able to handle twice the expected number of users without performance degradation.

- **SCA-2:** New features should be easily integrated without causing major disruptions.

2.3.7 Maintainability

The app should be easy to maintain and improve over time.

- **MAI-1:** The code should be structured so that developers can add new features or fix issues within 2 days.

- **MAI-2:** Updates should be applied automatically without affecting ongoing user sessions.

2.3.8 Compatibility

The app should work well on various devices and platforms.

- **COM-1:** The app should support the latest versions of Android and iOS, as well as the two most recent major versions.

- **COM-2:** The app should adapt to different screen sizes, from small phones to large tablets, without losing functionality.
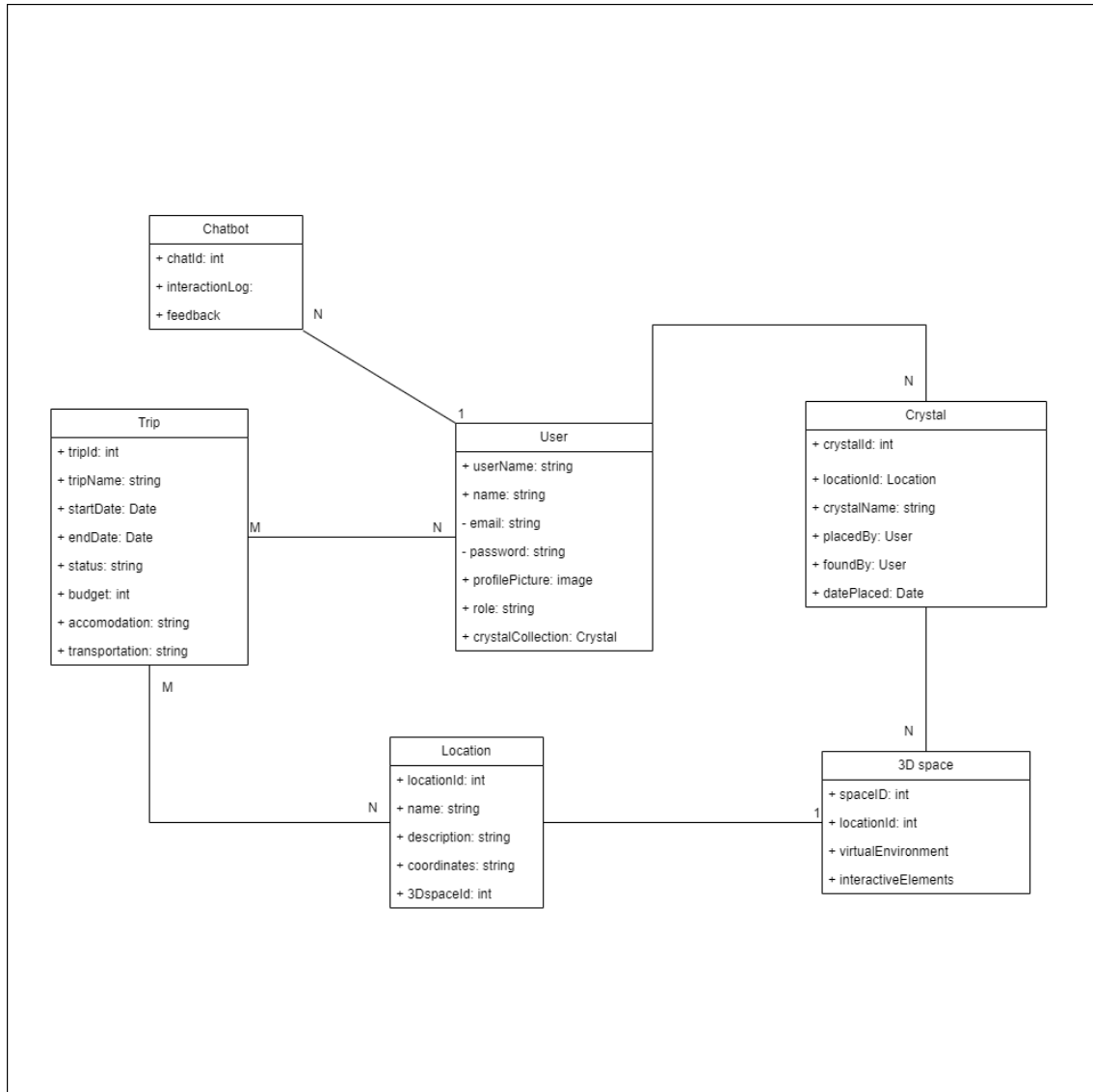
2.4   Domain Model

Figure 2.2: Domain Model

Chapter 3

System Overview

Safar is a tourism application available on both web and mobile, offering users with a variety of features developed to help users plan trips, discover new locations, and engage in a gamified experience by interactive with the 3D model of destination.

Context

Tourism in Pakistan is a vital sector, but discovering, planning, and navigation of popular tourist destinations is challenging due to lack of organized information. Safar tries to solve the problem for its users by creating an experience that is virtual and immersive when one travels to a place by experiencing it firsthand, creating personalizing travel plans and interacting with other users.

The web version of Safar is dedicated to trip planning, making an itinerary, and getting access to information through the chatbot service. The mobile version offers superior features in the gamification part: it allows users to interact with 3D models of destinations, drop/collect virtual gems, and get points, making traveling experience engaging and competitive.

Functionalities of Safar

1. 3D Destination Exploration:

    - Users can search for a location and view the 3D model for it. Model will be created using 3D Gaussian Splatting which transforms the 2D images into 3D scene.

2. Gamification:

    - Users visiting a location can drop a virtual gem at specific coordinates within the 3D model, which will then be visible to other users. Other travelers can collect these gems to earn points, which are reflected in the global leaderboard.

3. Itinerary Generation:

- Users can input their preferences and budget to generate a custom itinerary for their trip, suggesting destinations, accommodations, and activities.

4. Chatbot:

- The application includes a chatbot that assists users with any questions about tourist destinations or travel tips. This feature helps users get immediate answers, improving their overall experience.

5. Leaderboard and Social Features:

- Safar encourages social interaction through its leaderboard, where users can see how their gem collection and points compare to others.

3.1 Architectural Design

The system for Safar is decomposed by several modules with each module handling distinct functionality of the application. Modular approach that Safar follows ensures that the system is scalable, maintainable, and can function independently without affecting the rest of the system.

Below is a high-level overview of how the the modules collaborate to achieve the overall functionality of the system.

1. Frontend Module

- Sub-modules:
  - Web Interface
  - Mobile Interface
- Description:
  - Frontend module is responsible for all the user interaction and experience. It displays all the relevant information such as 3D models, travel-related information, accessibility to leaderboard or chatbot, and required input forms.
- Interaction:
  - The main interaction of frontend interfaces is with the API Gateway, which routes user request to backend services as needed.

2. API Gateway

- Description:

- The API Gateway handles all the incoming user requests from the frontend. It then routes each request to the appropriate microservice and handles cross-cutting concerns such as authentication.

- Interaction:

  - API Gateway interacts directly with the backend microservices, which include 3D model Service, Leaderboard Service, Chatbot Service, Itinerary Service, etc.

3. 3D Model Service

   - Description:

     - The 3D Model Service is responsible for processing and delivering 3D model of the requested locations, which then is rendered by the frontend.

   - Interaction:

     - This service interacts with frontend by providing with the 3d model through the API Gateway.

4. Gamification Service

   - Description:

     - The Gamification Service is responsible for game-like features, which include ability to drop or collect gems within a 3D model. It also tracks gem data, user score, and updates leaderboard accordingly.

   - Interaction:

     - It interacts with Gem Database to store and retrieve gem data, Leaderboard Service to update user ranking. For mobile application, it interacts with Unity backend to manage gem objects within 3D model.

5. Itinerary Service

   - Description:

     - This Service generate personalised itineraries based on user input such as budget, interests and travel date, using the data of location and accomodations from external APIs.

   - Interaction:

     - Interacts with the Itinerary Database to store user-generated itineraries and External APIs to get information on location and activities. Lastly, API Gateway is used to deliver the itinerary generated to the frontend.

6. Chatbot Service

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- Description:

    - The Chatbot Service handles user queries regarding locations, travel tips or other relevant information. It use NLP (Natural Language Processing) to interpret user query and provide response.

- Interaction:

    - This Service interacts with the Itinerary database and External APIs to fetch relevant information for the user query, then API Gateway is used to communicate with the frontend.

7. Leaderboard Service

    - Description:

        - The Leaderboard Service is responsible for managing the social features of the application. It tracks user scores based on gem collection.

    - Interaction:

        - This Service interacts with Leaderboard Database to store and retrieve user score data and Gamification Service to update user scores when they collect gems. Interaction with API Gateway to display leaderboard on frontend.

8. Data Storage Module

    - Sub-modules:

        - 3D Model Database
        - Gem Database
        - Itinerary Database
        - Leaderboard Database
        - User Database

    - Interaction:

        - Each backend service interacts with its respective database to store and retrieve necessary data.

9. External APIs

    - Description:

        - External APIs will be used to fetch live data such as hotels, transport, and weather to ensure real-time and updated information.

    - Interaction:

        - These APIs will connect directly with Services that require it.

Considering the above modular approach, Safar follows a Microservices Architecture to ensure scalability and fast response times. Each major feature of the application is managed by an independent microservice, allowing the system to scale based on specific load requirements.

Diagram below shows each module and its relationship with others in the system.
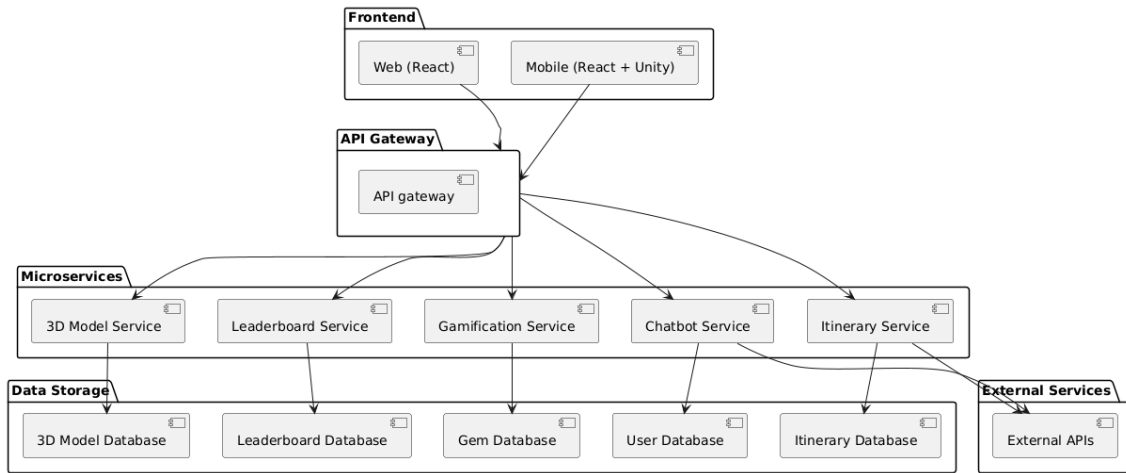
Figure 3.1: Architecture Diagram

3.2 Design Models

3.2.1 Activity Diagram

Diagrams below show process flow of Safar for web and mobile users, where any user (Logged in or Guest) can search for location and view 3D model. User can create itinerary based on their input or ask queries about location and receive location-related answers. If user wants to save their generated itinerary or access social features they are prompted to log in or create an account. For mobile application, if user is in 3D scene area they can drop or collect gems placed by other users else they are notified and virtual exploration is allowed.

Figure 3.2: Activity Diagram - Web
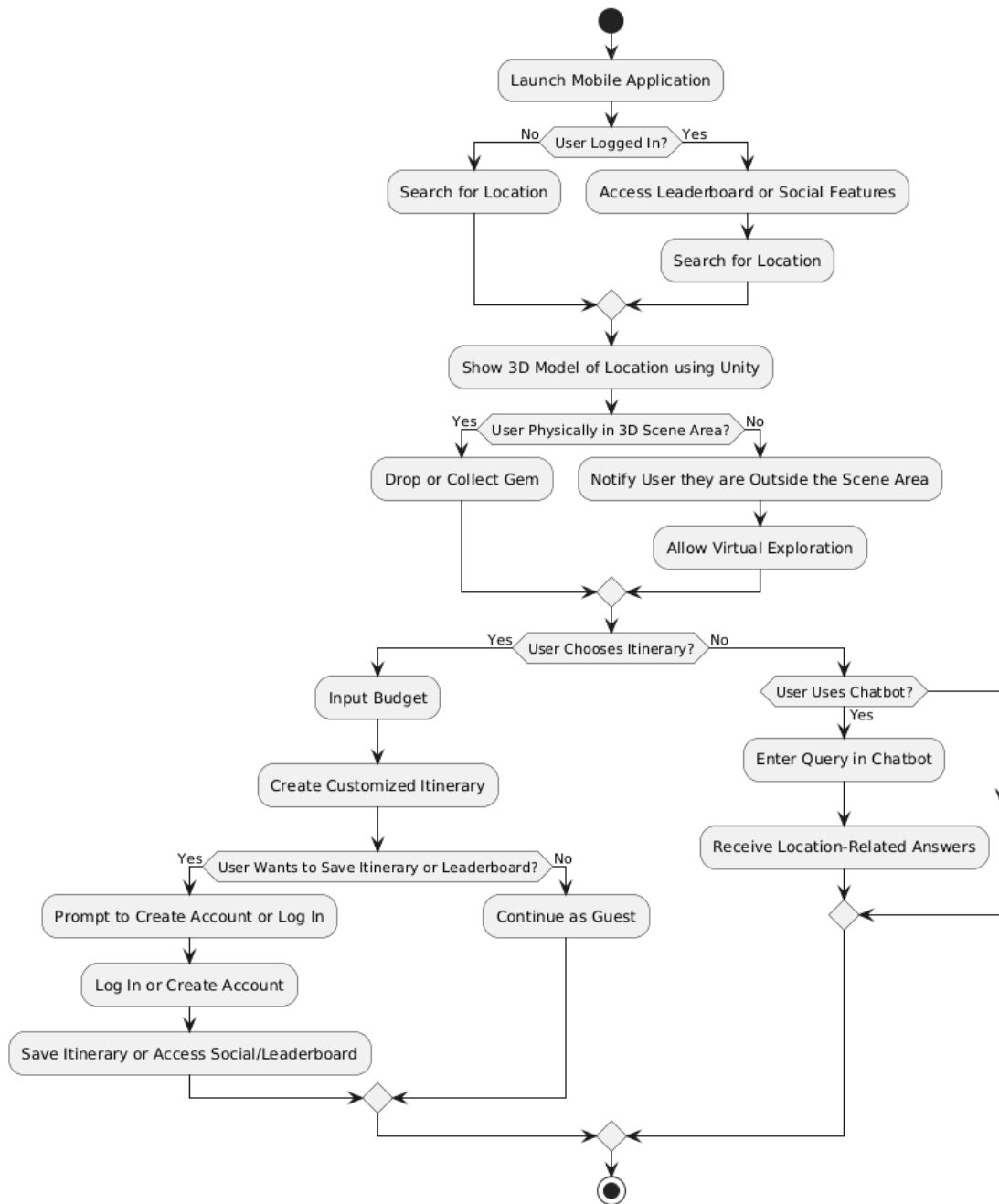
Figure 3.3: Activity Diagram - Mobile

3.2.2 Data Flow Diagram

Data Flow Diagrams for Safar shows how data flows between sources, sinks and data stores. Figure 3.4, shows how data flows at a higher system level while Figure 3.5, shows data flow at a lower level with each source, sink and data store interaction.
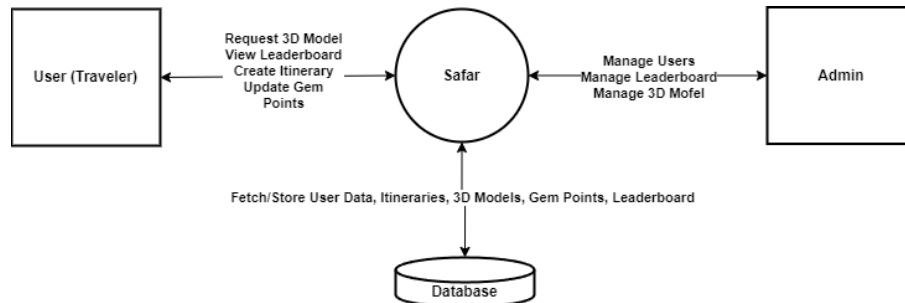
Figure 3.4: Data Flow Diagram - High Level
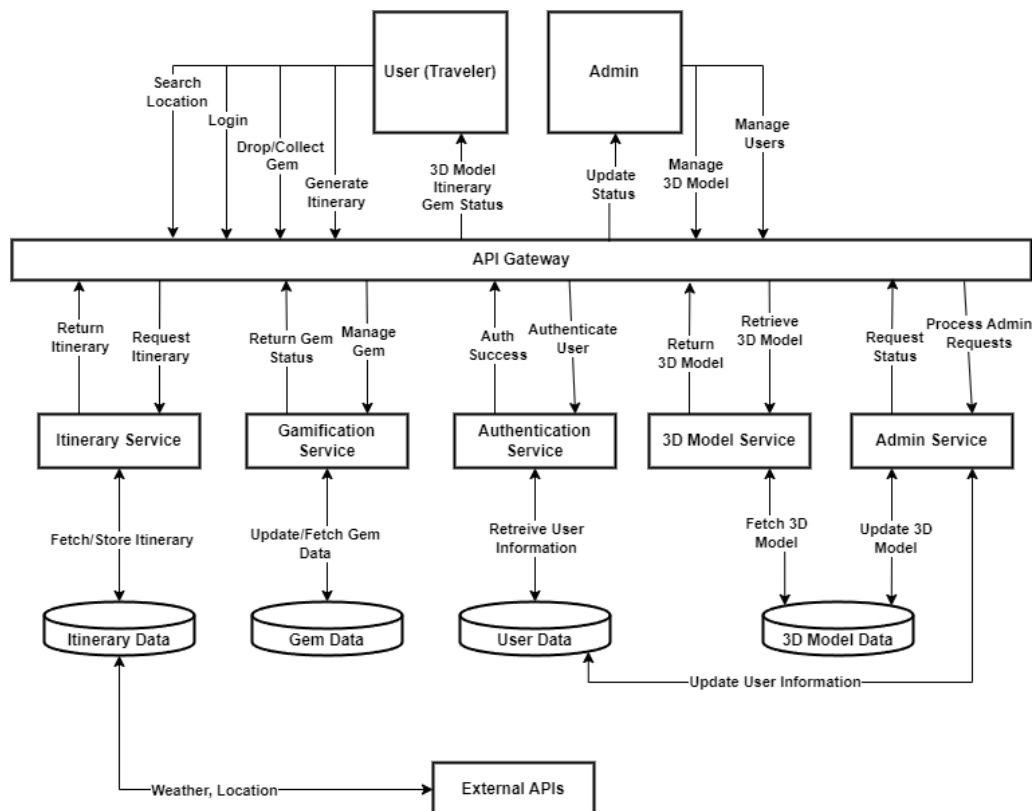
Figure 3.5: Data Flow Diagram - Low Level

3.2.3 System-level Sequence Diagram
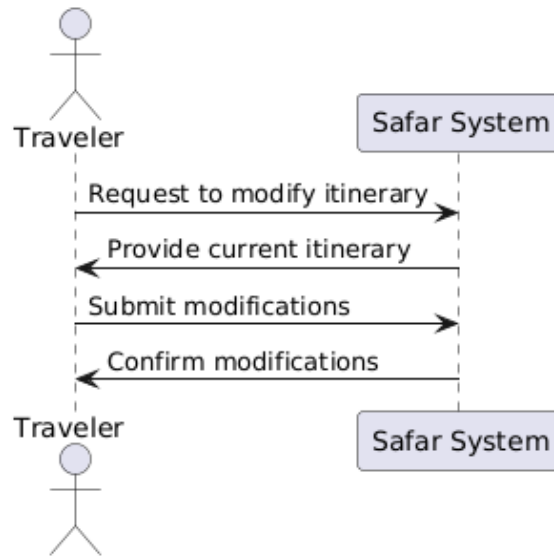
Figure 3.6: SSD - Modify Itinerary
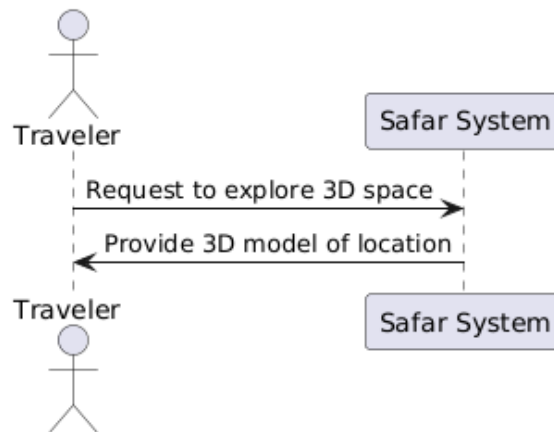
Figure 3.7: SSD - Explore 3D Scene

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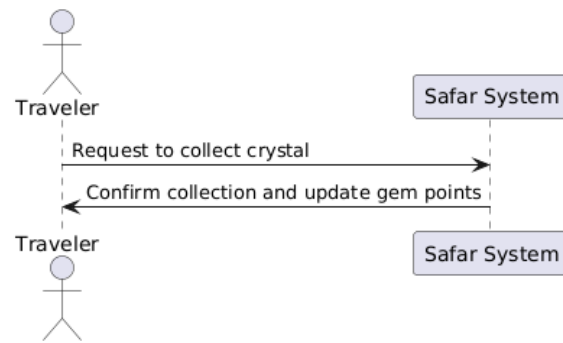
Figure 3.8: SSD - Collect Crystal
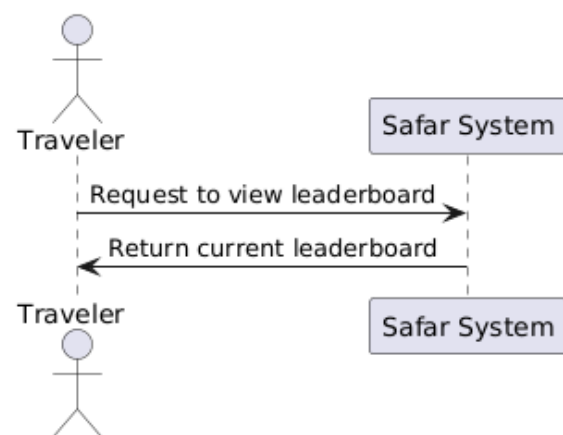
Figure 3.9: SSD - View Leaderboard
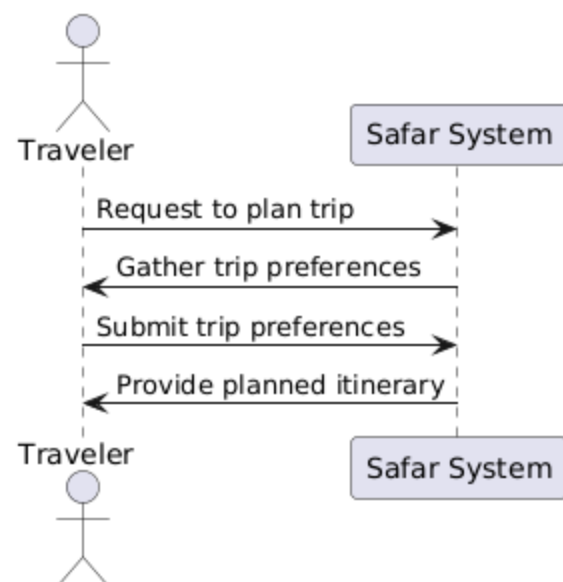
Figure 3.10: SSD - Plan Trip
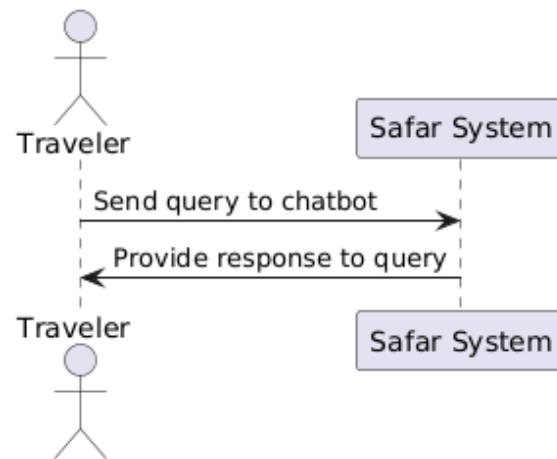
Figure 3.11: SSD - Interact with Chatbot
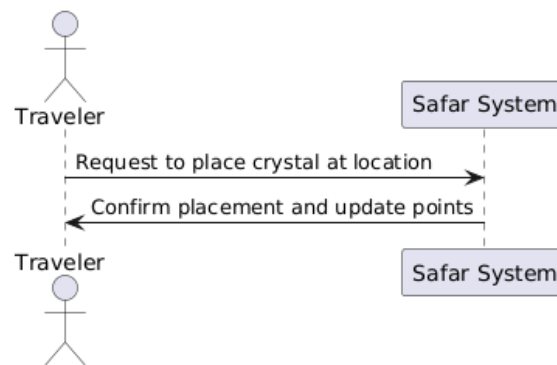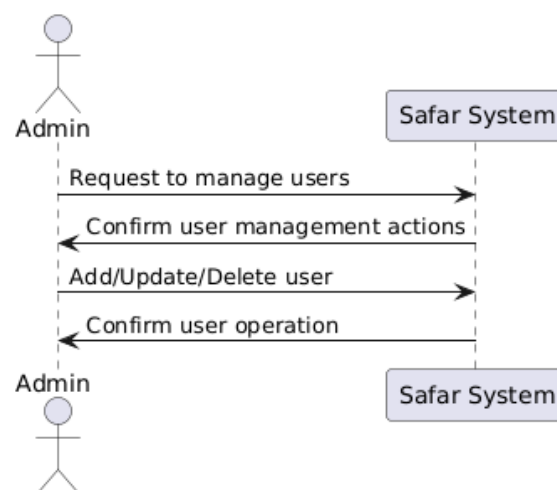

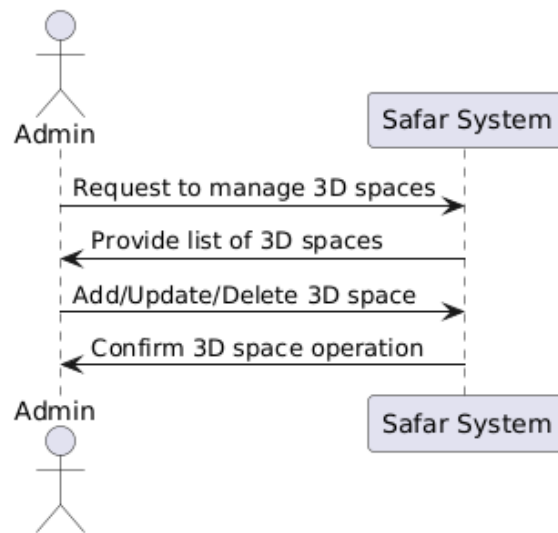Figure 3.12: SSD - Place Crystal

Figure 3.13: SSD - Manage Users

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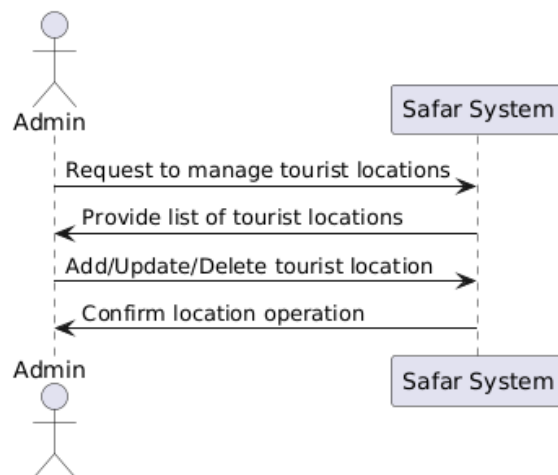Figure 3.14: SSD - Manage 3D Scene

Figure 3.15: SSD - Manage Tourist Locations

3.2.4   State Transition Diagram
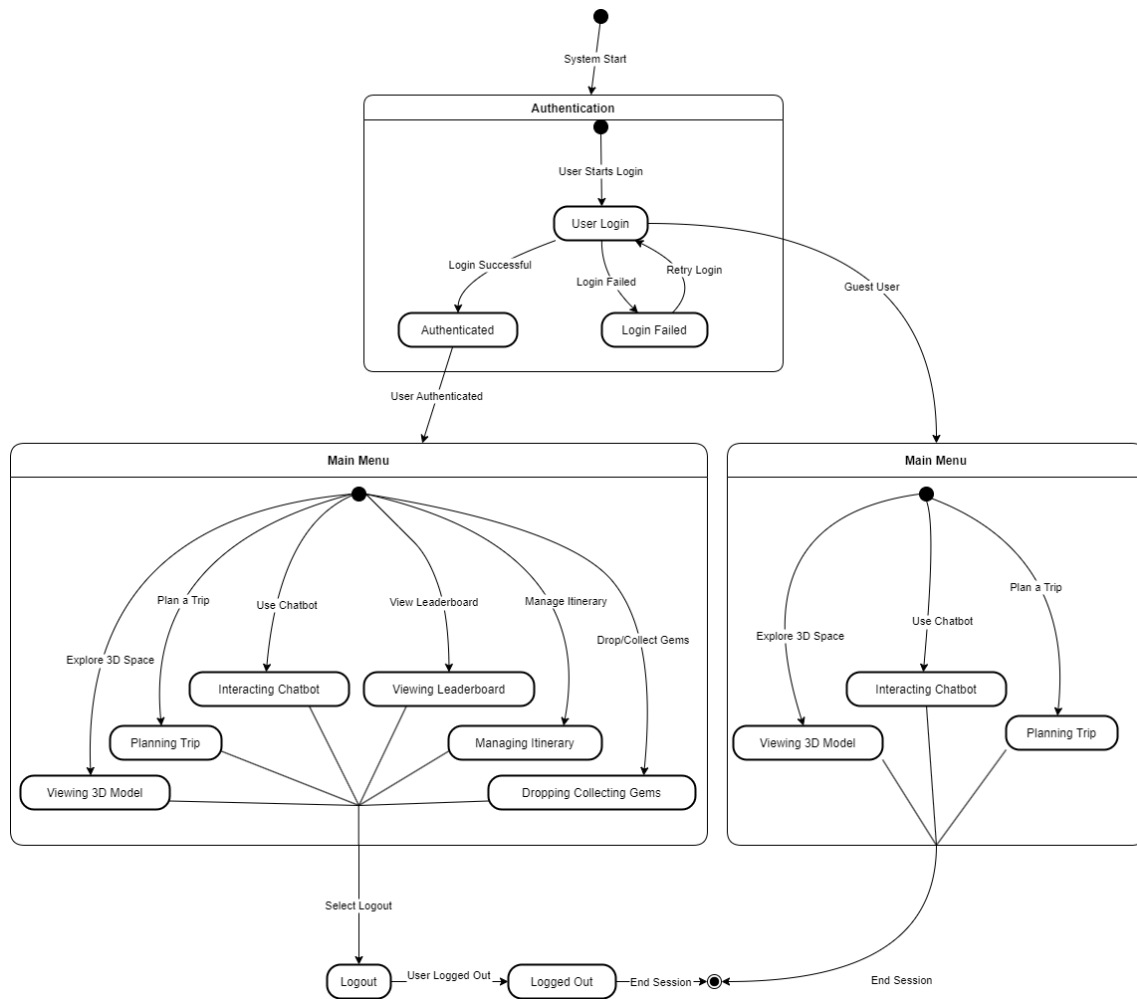

Figure 3.16: State Transition Diagram

3.3   Data Design

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Bibliography