Tribhuvan University

Academia International College

Final Year Project Report

On

MyTrailMate -A trekking risk management system

[CSC – 412]

Under the supervision of

Mr. Anup Shrestha

Submitted by

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Submitted to

Department of Computer Science and Information Technology

Academia International College

Institute of Science and Technology

September,2025

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A final year project submitted in partial fulfillment of the requirement for the degree of Bachelor of Science in Computer Science and Information Technology awarded by Tribhuvan University.

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Recommendation Letter of Supervisor

I hereby recommend that the project work report prepared under my supervision by Inuka Mulmi (29011/078) and Saejaina Singh Maharjan (29027/078) entitled "MyTrailMate – A trekking risk management system" be accepted as fulfilling in partial requirements for the degree of Bachelors of Science in Computer Science and Information Technology. In my best Knowledge, this is an original work in Computer Science and Information technology.

……..

Mr. Anup Shrestha

Project Supervisor

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Certificate of Approval

This is to clarify that this project prepared by Ms. Inuka Mulmi and Ms. Saejaina Singh Maharjan entitled "MyTrailMate – A trekking risk management system" in partial fulfilment of the requirement for the degree of B.Sc. in Computer Science and Information Technology has been well studied. In our opinion, it is satisfactory in the scope and quality as a project for the required degree.

…… Mr. Anup Shrestha Supervisor Department of Computer Science and IT Academia International College	…… Mr. Bishwas Ram Mathema HOD/Program Coordinator Department of Computer Science and IT Academia International College
…… Internal Examiner Academia International College	…….. External Examiner Central Department of CSIT Tribhuvan University

Acknowledgement

We owe my most profound appreciation to Academia International College for giving us a chance to work on this project as part of our syllabus.

Special thanks to our supervisor, Mr. Anup Shrestha (Lecturer, Academia International College), for his consistent guidance, support, and feedback throughout the report's creation. We are generously obligated to him for providing this excellent opportunity to expand our knowledge. It helped us a lot to realize what we studied for.

We would like to express our sincere gratitude to all those individuals, families, friends, colleagues, and teachers for supporting and helping us a lot in finalizing this project within the limited time frame by providing valuable insights and feedback on the report.

Thanking You,

Inuka Mulmi (T.U. Symbol No. 29011/078)

Saejaina Singh Maharjan (T.U. Symbol No. 29027/078)

Abstract

MyTrailMate is a mobile-based trekking companion application developed to enhance safety, accessibility, and guidance for trekkers in remote areas. Many trekkers face difficulties such as poor connectivity, lack of real-time support, and limited safety resources during their journeys. MyTrailMate helps to manage these challenges by offering offline access, customized risk profiling, as well as emergency SOS. Designed with React Native as the frontend technology and Firebase as the backend, the app provides a reliable and user-friendly experience suitable for challenging trekking environments. The system includes a dynamic risk scoring feature that evaluates factors such as health, age, trekking experience, and trail difficulty to generate a personalized safety score. There is also the SOS alert facility that can queue offline messages, automatically syncing when internet connection is reinstated. Additional features like offline map access, safety tips, and trek history provide further support to users during their treks. MyTrailMate therefore is a dependable trekking companion, combining mobile technology with practical safety tools to minimize risks, save time, and enhance the overall trekking experience.

Keywords: *Trekking companion app, Risk management, Offline support, SOS alert, React Native, Firebase*

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List of Abbreviations

DB	Database
GPS	Global Positioning System
ICT	Information and Communication Technology
iOS	iPhone Operating System
JS:	JavaScript
SMS	Short Message Service
SOS	Save Our Soul
TAAN	Trekking Agencies' Association of Nepal
TSX	TypeScript
VS Code	Visual Studio Code

Chapter 1: Introduction

1.1 Introduction

MyTrailMate is a Trekking Risk Management System that is a mobile-based Android application developed using the open-source cross-platform framework React Native, with Firebase serving as the backend service provider. The development process utilizes both JavaScript (JS) and TypeScript (TSX) to ensure modular, maintainable, and type-safe code throughout the application. The application has been designed with the aim of providing an efficient user experience by using responsive navigation, offline capabilities, and a lightweight, usable user interface suitable for remote use contexts. MyTrailMate is built to support dynamic data flow, real-time interactions, and platform scalability. The use of TypeScript enhances the development workflow by reducing runtime errors and enforcing stricter code standards, which is essential for handling complex user scenarios in a trekking environment. The application architecture follows a modular and reusable design approach that enhances the easy combination of various screens, features, and logical flows.

Trekking is one of the most adventurous yet risky outdoor activities. While it offers opportunities for exploration, physical endurance, and personal growth, it also exposes trekkers to several challenges such as unpredictable weather, difficult terrains, health risks like altitude sickness, and limited communication infrastructure in remote areas. Many incidents during trekking occur due to lack of preparation, limited access to timely information, or absence of efficient risk management tools. Traditional resources such as guidebooks, paper maps, or even generic mobile applications often fail to provide the real-time assistance and safety measures required in emergency scenarios.

In this context, there is a strong necessity for a digital solution that can combine safety, guidance, and risk management in a single platform. MyTrailMate aims to fill this gap by offering features such as personalized risk assessment, emergency SOS support, offline trekking tips, and dynamic recommendations tailored for trekkers. Unlike existing trekking or navigation apps that primarily focus on route tracking, this system emphasizes safety-first design and practical usability in resource-constrained environments. By integrating modern mobile technologies with the unique requirements of trekking, MyTrailMate aspires to serve as a reliable companion that enhances safety, preparedness, and overall trekking experiences.

1.2 Problem Statement

Many trekkers still depend on basic tools or general-purpose applications that do not provide sufficient safety support, especially in remote trekking routes where internet connectivity is poor or entirely unavailable. Most existing solutions are limited in scope, lacking features such as personalized risk assessment, offline emergency alerts, and real-time assistance during critical moments. This creates significant challenges for trekkers who must make quick decisions in unpredictable conditions without access to reliable guidance. MyTrailMate is designed to address these issues by offering an easy-to-use, mobile-based trekking application that prioritizes safety, accessibility, and user experience. While essential functions like login and data synchronization require internet connectivity, the system emphasizes offline usability for critical tools, ensuring trekkers are not left vulnerable when disconnected. Core features include a dynamic risk scoring system that evaluates individual factors such as age, health, experience, and trail difficulty; an SOS emergency alert with fall detection and offline message queuing; interactive offline maps with safety tips; and secure data management with automatic syncing once connectivity is restored. By combining these capabilities into a user-friendly and mobile-optimized design, MyTrailMate serves as a dependable digital companion, helping trekkers minimize risks, stay informed, and enhance their overall trekking experience even in the most challenging environments.

1.3 Objectives

The specific objectives are:

- To build a risk score calculator based on user health and trekking conditions
- To provide offline access to emergency survival tools and maps
- To design a simple and intuitive user interface for easy navigation
- To implement an SOS emergency feature

1.4 Scopes and Limitations

Scopes:

- The app is designed for Android mobile devices using React Native for cross-platform flexibility.
- Provides personalized risk scores based on user input such as health, age, experience, and trail difficulty.

- Includes an SOS feature for emergencies, with offline queuing and automatic syncing when the internet is restored.
- Uses Firebase for authentication, secure data storage, and real-time data synchronization.
- Provides safety tips, alerts, and recommendations to improve decision-making during treks.
- Designed with a user-friendly and mobile-optimized interface for quick access to features even in stressful situations.

Limitations:

- Some features such as login, registration, and data syncing require an active internet connection.
- The app currently supports only Android devices and does not have an iOS version.
- The app is intended for use within Nepalese trekking regions initially and may have limited trail data for other areas.
- SOS emergency alerts are currently stored in the system/database but are not forwarded to users or emergency contacts.
- The application couldn’t be implemented in mobile version completely.

1.5 Methodology

For the development of our project, MyTrailMate, we employed the Iterative Waterfall Model. This approach combines the structured, phase- nature of the traditional waterfall model with iterative feedback loops, allowing for flexibility and continuous refinement at each stage of development. Given the safety-critical features and the evolving nature of user requirements, this model proved ideal for our system.

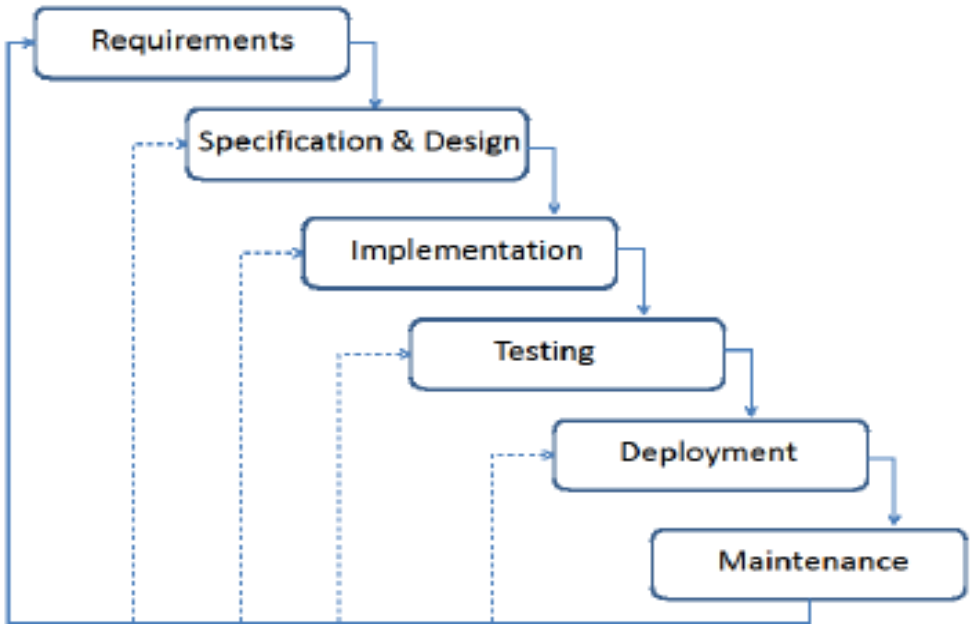

Figure 1.1: Iteration Waterfall

We used the Iterative Waterfall Model in developing MyTrailMate because it offered a structured yet adaptable method of developing the system. This model allowed us to have a sequential approach with incorporation of betterments at every step based on continuous feedback from our supervisor. Development started with an elaborate requirement analysis followed by system design during which React Native was selected for the frontend and Firebase for the backend. We started with the initial iteration where we focused on including fundamental capabilities such as user authentication and the SOS alert system. Subsequent iterations deployed advanced features such as real-time risk scoring, offline survival packs, and enhancements to the user interface. This enabled us to achieve gradual progress, continuous improvement, and a stable deployment of the system that was in line with functional and user requirements

1.6 Report Organization

This project report has been prepared as part of the mid-defense phase and includes all completed sections up to the current stage of development. The report begins with the initial sections such as the Title Page, Acknowledgement, Abstract and Table of Contents, Figures, and Tables.

The main body of the report is structured into planned six chapters. For the final, the following chapters have been prepared:

Chapter 1: Introduction

This chapter introduces the project and includes the project overview, problem statement, objectives, scope and limitations, and methodology.

Chapter 2: Background Study and Literature Review

This section covers the background of the project along with the review of related works, including existing systems and research papers that influenced the development of MyTrailMate.

Chapter 3: System Analysis

This chapter explains the system requirements, feasibility study, and functional analysis. It includes a use case diagram and a Gantt chart showing the current progress and planned tasks.

Chapter 4: System Design

This chapter includes the system architecture, user interface design, data flow, and algorithm explanation.

Chapter 5: Implementation and Testing

This chapter covers the actual implementation process, development tools, and testing procedures to ensure system functionality.

Chapter 6: Conclusion and Final Recommendations

This chapter describes the final outcomes from the completed project, its impact, and future scope.

The report will conclude with References in IEEE format and Appendices containing screenshots.

Chapter 2: Background Study and Literature Review

2.1 Background Study

In recent years, trekking has grown in popularity as more people seek escape from city life and look for ways to connect with nature. However, this rise in interest has also highlighted the ongoing lack of proper safety tools and guidance for trekkers, especially in remote areas. Many trekking-related incidents still occur due to poor planning, lack of awareness, and absence of real-time support. Despite the advancement in mobile technologies, most trekking apps remain focused on basic features like route tracking or map viewing, without addressing deeper concerns such as risk awareness, offline emergency readiness, and personalized user support.

The issue becomes more serious when trekkers overestimate their physical readiness or underestimate the environmental challenges of high-altitude or remote regions. Most first-time trekkers, and even some experienced ones, set out with little to no knowledge of the risks involved. The absence of a smart, context-aware system that provides individual-based recommendations and safety alerts contributes to this growing problem. Many existing apps are also not built to function offline, which is a major drawback for users traveling through disconnected zones where help is most needed.

Another major concern is that some platforms are overloaded with features that are either paid, locked, or not practical in actual trekking scenarios. This leaves users with tools that are either too generic or too complex to be helpful on the trail. The need of the hour is a system that brings simplicity, real usability, and personal safety to the forefront.

This project, MyTrailMate, aims to bridge that gap. It is developed with a vision to not only help users plan their treks but also guide them throughout the journey with safety-first features. In a world where digital health, smart recommendations, and offline capability can save lives, trekking applications must evolve beyond maps and distances. There is a need for systems that deliver useful insights, adapt to different users, and are accessible without barriers like internet dependency or payment walls. A thoughtful solution could bring significant change in how trekkers approach adventure—with more awareness, confidence, and security.

2.2 Literature Review

A review of existing trekking and safety platforms provides useful insights and highlights key gaps that MyTrailMate aims to address. Apps like AllTrails offer trail mapping, elevation profiles, and detailed route descriptions. These features are valuable for trekkers to plan their journeys in advance. However, while AllTrails excels at providing an extensive database of trails, it heavily depends on continuous internet connectivity, which is not always reliable in remote mountain regions. This guided our approach to offering offline trail information in a clean, mobile-friendly format using map libraries and local caching [1], [2], [3]. Similarly, Gaia GPS supports offline map downloads, route planning, and waypoint recording, aligning with MyTrailMate's offline-first philosophy. Yet, Gaia GPS often requires a subscription for advanced offline features, which can limit accessibility. In contrast, MyTrailMate emphasizes free access to essential offline features, ensuring trekkers can use critical safety tools without additional costs [4], [5], [6], [7].

In terms of safety and emergency preparedness, several existing platforms provide valuable inspiration. For instance, the Red Cross Emergency app offers structured first-aid guides and checklists, but it is designed for general disaster management rather than trekking-specific risks. Similarly, bSafe and Life360 focus on emergency alerts and group connectivity, but their solutions are built around real-time location sharing, which is outside the scope of MyTrailMate. Instead, MyTrailMate's SOS button is designed to generate and store alerts within the system database, ensuring they are recorded securely even without immediate communication. Future updates may enable push notifications or SMS delivery, but the current focus remains on offline compatibility and reliability [8].

In Nepal, platforms such as the Great Himalaya Trails provide curated trekking routes, permit requirements, and trail updates. However, these lack real-time safety alerts or personalized risk evaluation, which justifies MyTrailMate's unique inclusion of a risk score calculator based on user health, prior trekking experience, and trail difficulty [9]. The Trekking Agencies' Association of Nepal (TAAN) also provides resources related to permits and guides but is primarily business-oriented rather than safety-focused. By comparison, MyTrailMate seeks to directly empower trekkers themselves with personalized, safety-first tools that go beyond administrative information [10].

Academic research also validates the approach taken by MyTrailMate. Upadhayaya emphasizes the importance of ICT-based safety systems in promoting sustainable adventure tourism in Nepal, noting that digital safety solutions increase both visitor confidence and tourism competitiveness [11]. Bai et al. stress the importance of context-aware assistance, where user data and environmental conditions are combined to provide timely support—an idea reflected in MyTrailMate's risk assessment approach [12]. Similarly, Jung et al. discuss communication strategies in areas with poor connectivity, supporting MyTrailMate's offline-first design, which uses caching and queued alerts to preserve data integrity until connectivity is restored [13]. Broader studies on offline-first mobile systems confirm that caching and local storage are critical for applications intended for remote regions, further reinforcing MyTrailMate's architectural decisions [14].

Other international platforms also highlight the gaps MyTrailMate addresses. Komoot, popular in Europe, provides route planning and community sharing but focuses more on fitness and navigation than safety. ViewRanger introduced augmented reality for peak recognition but does not offer personalized risk scoring. Wikiloc allows users to share GPS tracks but lacks structured safety and emergency tools. OsmAnd, based on OpenStreetMap, supports offline navigation, but again, it is not specifically tailored for trekking safety. These comparisons underline that while global apps excel in navigation, exploration, and community sharing, they often neglect trekking-specific risk management and offline safety systems, especially in challenging terrains like the Himalayas [8].

Overall, these reviewed platforms and studies guide MyTrailMate's positioning as a focused, safety-first trekking companion app. Unlike existing apps, it combines offline trail access, risk scoring, trekking tips, and database-stored SOS alerts into a single lightweight mobile application. By prioritizing safety and usability in resource-constrained environments, MyTrailMate fills a critical gap overlooked by both global and local solutions, making it a unique contribution to safe and sustainable trekking in Nepal.

Chapter 3: System Analysis

3.1 System Analysis

Before starting the development of the MyTrailMate app, a comprehensive task list was created, considering both functional and non-functional aspects. This was followed by an analysis of how the intended system should operate to ensure an optimal user experience focused on trekking safety and ease of use.

3.1.1 Requirement Analysis

1. **Functional Requirements**
    i. Risk Scoring: The system calculates a personalized risk score for each user based on factors such as age, health condition, trekking experience, and trail difficulty, along with real-time trekking conditions like weather and terrain. This helps users understand their individual risk level before and during the trek.
    ii. SOS Alert: The app includes an SOS feature that records alerts in the system database. Currently, these alerts are stored internally and are not forwarded to emergency contacts or users. Future updates aim to implement real-time alert delivery to trusted contacts for faster emergency response.
    iii. Safety Guides: Users have access to safety guides and first-aid information within the app, providing guidance on handling emergencies during trekking.
    iv. User Registration and Authentication: The system allows users to create accounts and securely log in, ensuring that personal information is protected and risk scoring data is personalized.
    v. Data Storage and Retrieval: All user data, risk scores, and SOS alerts are securely stored in the Firebase backend, ensuring that data is retrievable for reference or future analysis.

2. **Non-Functional Requirements**
    i. Performance: The app will perform smoothly on Android devices, providing fast response times and minimal lag, even during risk score calculations.

ii. Security: User data will be securely stored in Firebase, with real-time updates to ensure data integrity and protection against unauthorized access.

iii. Reliability: The system should operate consistently without crashes, especially during critical use cases such as risk scoring or SOS alert logging.

iv. Availability: The app should be accessible at all times, particularly during peak trekking seasons, ensuring that users can access safety information when needed.

v. Usability: The interface should be simple, intuitive, and easy to navigate, prioritizing emergency-related features for quick access.

vi. Data Integrity: All user inputs, risk scores, and SOS alerts must be reliably saved and retrievable without data loss.

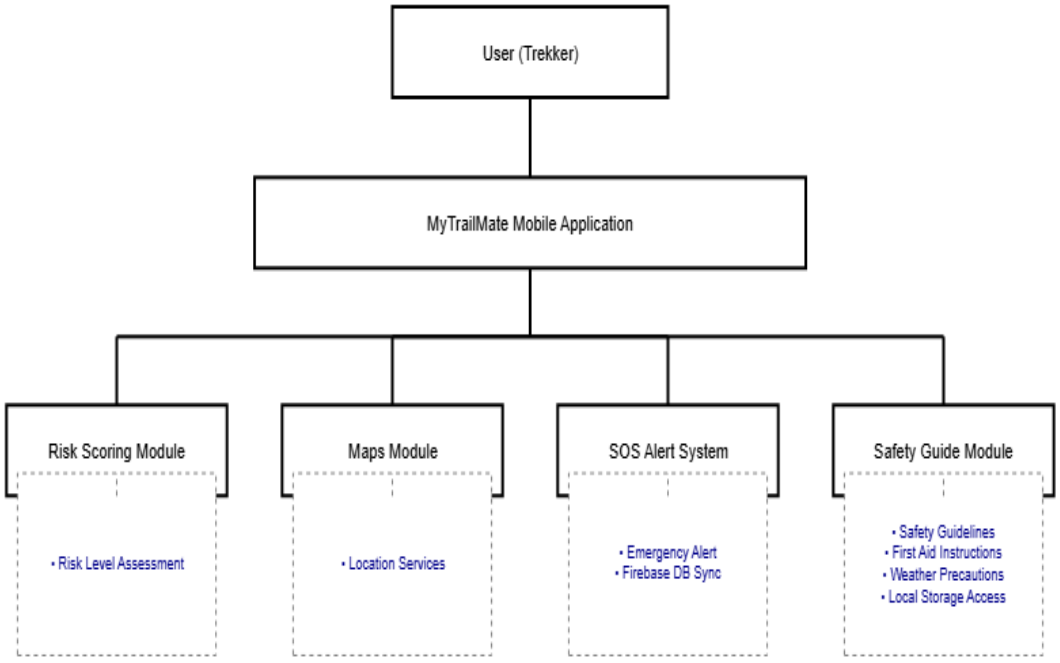

Figure 3.1: Block Diagram of the System

The diagram represents the structure of the MyTrailMate Mobile Application, designed for trekkers. At the core, the app integrates four main modules to enhance safety and experience. The Risk Scoring Module provides risk level assessments to help trekkers evaluate potential dangers. The Maps Module offers location services for navigation and route tracking. The SOS Alert System enables emergency alerts with Firebase database synchronization for quick responses. Finally, the Safety Guide Module

provides essential resources such as safety guidelines, first aid instructions, weather precautions, and offline access to critical information. Together, these modules ensure a secure and supportive trekking experience.

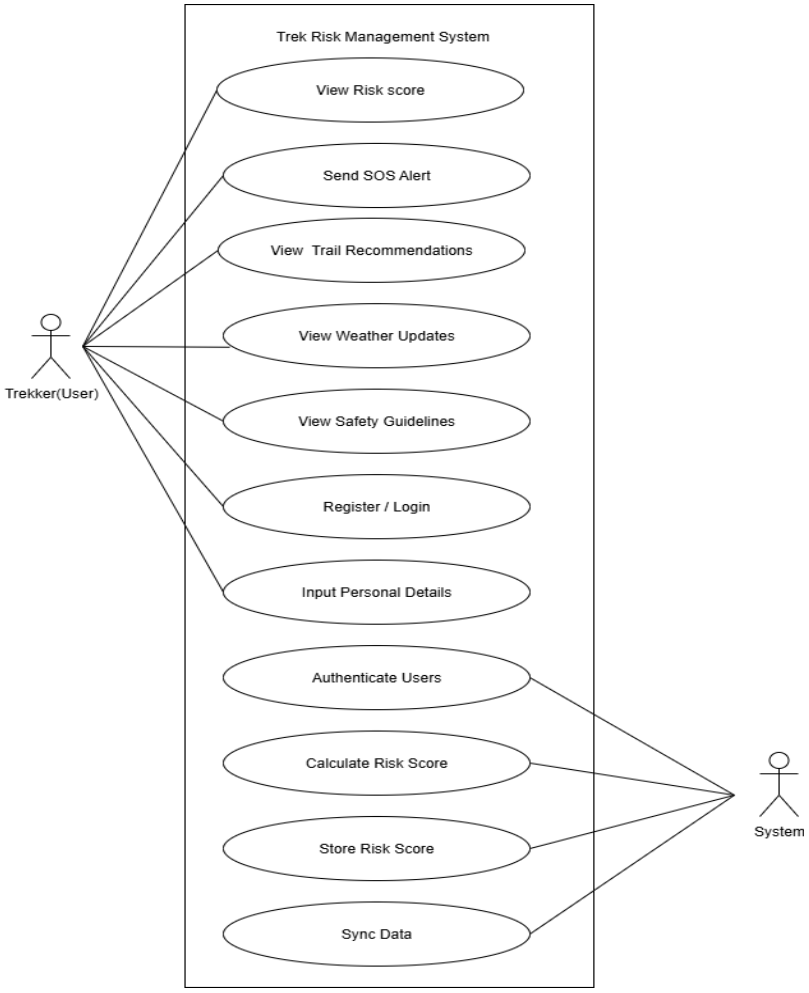

Figure 3.2: Use Case Diagram

The Trek Risk Management System allows a Trekker (user) to perform several key functions. The user can view safety guidelines and trail recommendations, both of which are provided by the Admin. The user can also view weather updates, which are handled by the System. Additionally, the user has the capability to send SOS alerts to the System for emergencies and to sync their data with the System. The Trekker can view their risk score, input personal details, and register or log in to the system, enabling personalized and secure access. Overall, the system facilitates interactions between the Trekker, Admin, and System to enhance trekking safety and information management.

3.1.2 Feasibility Analysis

Feasibility analysis evaluates whether the MyTrailMate project is achievable with the available time, resources, and technology. It helps ensure that the system is practical, sustainable, and worth the investment before full-scale development.

i. Technical Feasibility

MyTrailMate is technically feasible as it uses open-source and widely adopted technologies. The system is developed using React Native for the mobile frontend and Firebase for the backend, including authentication, database, and real-time services. These tools are well-documented, scalable, and suitable for offline. The technical infrastructure can be managed easily during development and testing using minimal hardware resources.

ii. Operational Feasibility

The system is operationally feasible because of its intuitive interface and mobile-first design. It is specifically tailored for trekkers and safety personnel. With features like real-time risk scoring**,** SOS alerts**,** offline survival kits**,** and the app is practical for use even in remote or low-network areas. Firebase ensures backend operations run seamlessly without needing complex server setups.

iii. Economic Feasibility

MyTrailMate is economically feasible since it uses free and open-source platforms. Firebase's free tier covers user authentication, Firestore database, cloud storage, and notifications for small-scale use. React Native allows cross-platform development, reducing development time and cost. No licensing costs are involved, and local testing does not require paid hosting or infrastructure, making the project financially viable for student and academic use.

iv. Schedule Feasibility

The project was planned carefully and executed within the academic timeline. Each phase had a defined start and end date, ensuring steady progress toward the final product.

Table 3.1: Tasks Scheduling

Task No.	Task Name	Start Date	End Date	Duration
1	Requirement Analysis & Planning	May 10	May 15	6 days
2	UI/UX Design & Firebase Setup	May 16	May 25	10 days
3	SOS Features	May 26	June 10	16 days
4	Risk Scoring Algorithm Implementation	June 5	June 20	15 days
5	Offline Survival Kit & UI Enhancements	June 15	July 1	17 days
6	Testing & Refinement	July 2	July 20	19 days
7	Documentation	May 10	July 31	82 days

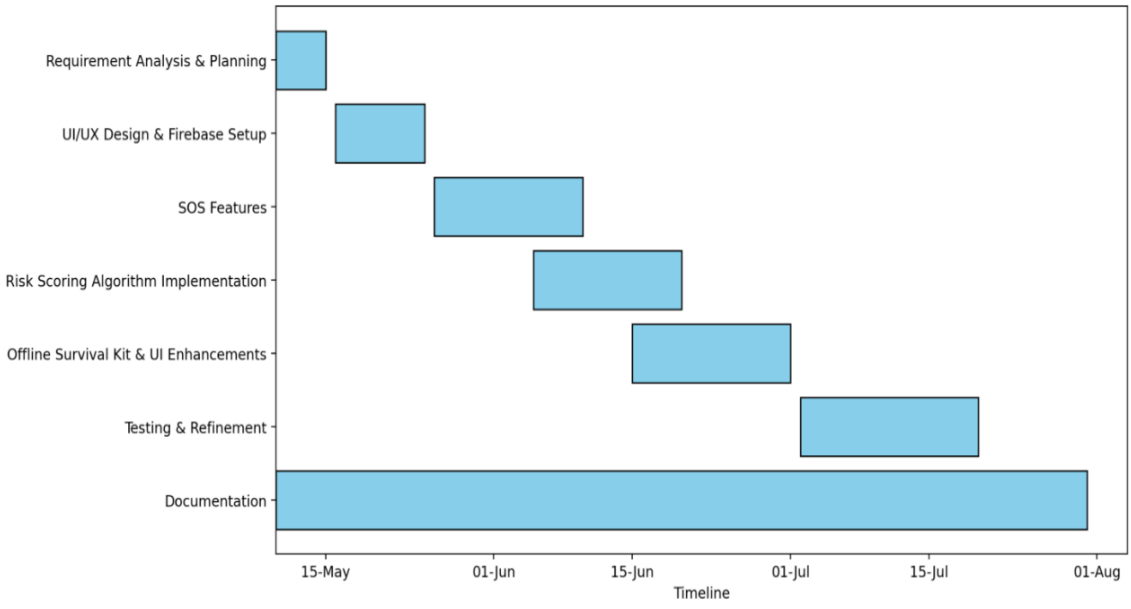

Figure 3.3: Gantt Chart

3.1.3 Object Modeling using Class and Object Diagram

The MyTrailMate – Trekking Risk Management System is designed using object-oriented principles where components are modeled as interacting objects. Core classes include User, Risk-Score, SOSAlert, Survival-Kit, and Trail-Recommendation**.** These objects encapsulate their attributes and methods, ensuring modularity, scalability, and ease of maintenance. The class diagram shows the static structure and relationships, while the object diagram demonstrates real-world instances such as a trekker with a generated risk score and an active SOS alert.

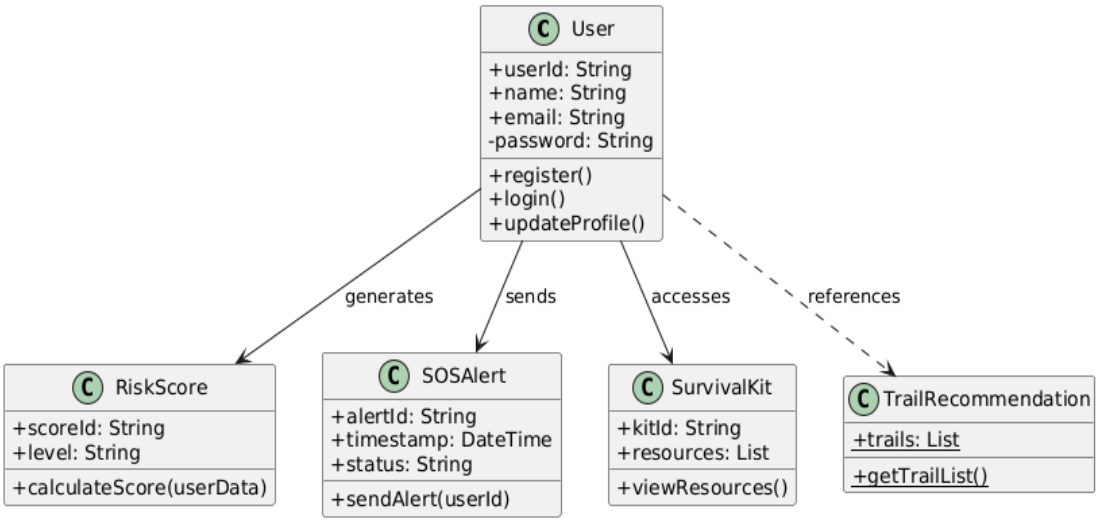

Figure 3.4: Class Diagram

The class diagram models the main components of the trekking risk management system. The User class is central, with public attributes like userId, name, and email, and a private password, allowing actions such as register(), login(), and updateProfile(). Users generate RiskScore objects, send SOSAlerts, and access SurvivalKits, each with relevant attributes and methods. TrailRecommendation provides static trail suggestions that users can reference but not modify. Solid arrows show direct associations, while the dashed arrow indicates dependency. Public (+) and private (-) visibility is used to ensure proper encapsulation.

3.1.4 Dynamic Modelling using Sequence Diagram

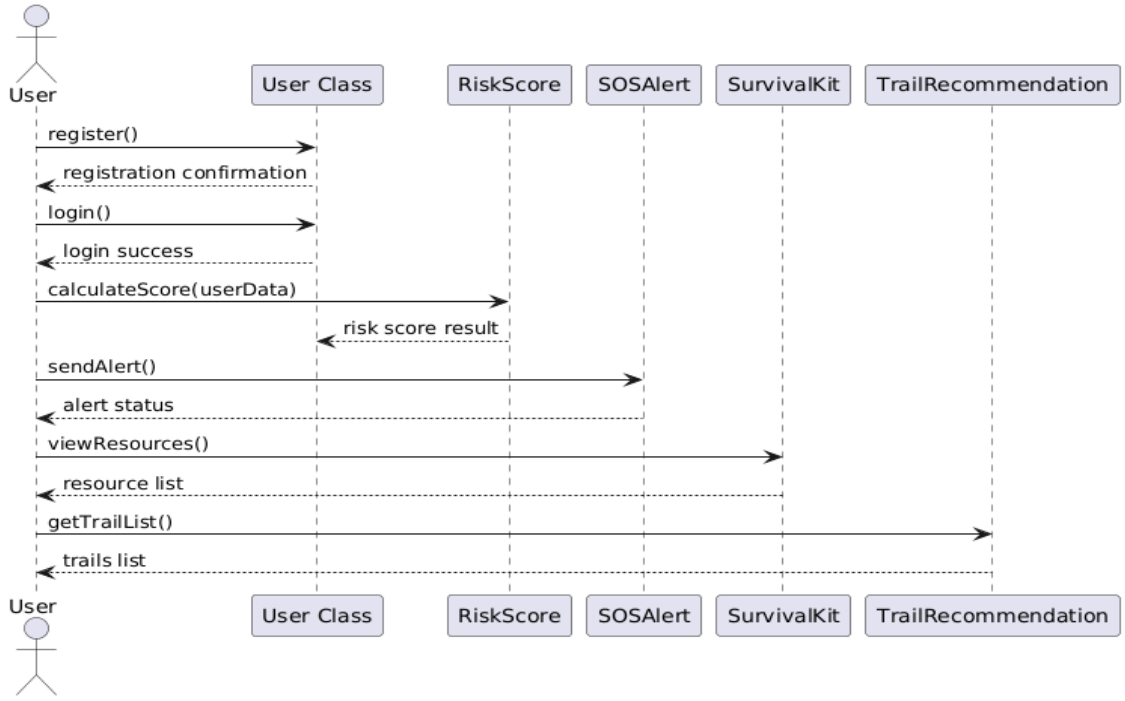

Figure 3.5: Sequence Diagram

The sequence diagram illustrates how a user interacts with the trekking risk management system during typical operations. The User actor initiates actions by calling methods on the User class, starting with register() to create an account and login() to access the system. After logging in, the user can generate a risk score by invoking calculateScore(userData) on the RiskScore class, which returns the computed risk level. In case of an emergency, the user can trigger sendAlert() on the SOSAlert class, receiving the alert status in response. The user can also access a SurvivalKit to view available resources using viewResources(), and refer to TrailRecommendation to retrieve the static list of suggested trails. Solid arrows indicate the flow of messages between the user and classes, showing the order of operations and how each class responds, providing a clear picture of the system's runtime behavior.

3.1.5 Process modelling using Activity Diagrams

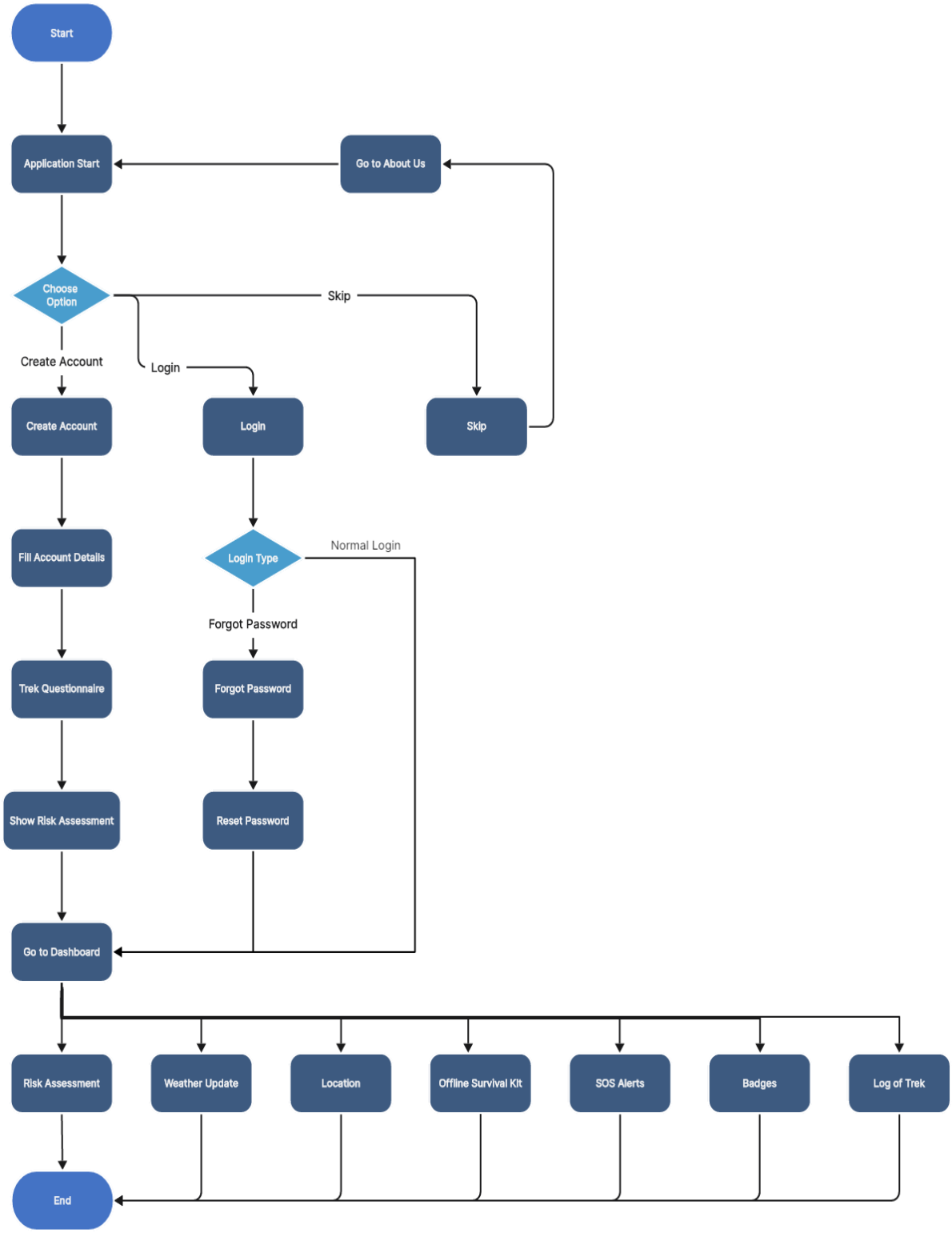

Figure 3.6: Flowchart of the system

Chapter 4: System Design

4.1 System Design

MyTrailMate follows a layered architecture that separates the system into distinct layers, each responsible for a specific part of the functionality. This architecture enhances maintainability, scalability, and modular development. The application consists of three main layers:

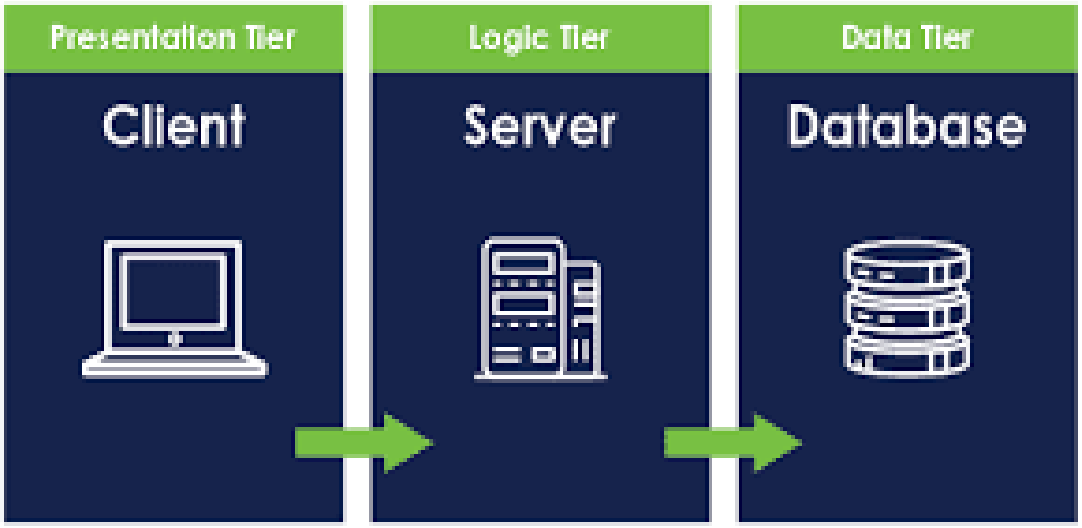

Figure 4.1: Layered Architecture of the System

- The Presentation Layer handles user interaction and interface rendering using React Native.
- The Application Layer manages core logic such as risk score calculation, fall detection, and emergency alert handling.
- The Data Layer interacts with Firebase services for authentication, real-time database, and cloud messaging.

Each layer communicates only with its adjacent layers, ensuring a clean separation of concerns and easier future updates or testing.

4.2. Algorithm Details

This section describes the core algorithms implemented in MyTrailMate to enable intelligent risk assessment, real-time fall detection, and effective emergency alert handling. The system leverages Expo Go's built-in sensor APIs to streamline the development and ensure reliable performance across devices.

4.2.1 Weighted Sum Algorithm – Risk Score Calculation

The Weighted Sum Algorithm is a widely used method for combining multiple factors into a single overall score. Each factor is assigned a weight according to its importance, so that more critical factors have a greater influence on the final result. For example, when assessing a trekker's readiness, health may be considered the most important factor and given the highest weight, while planning, experience, or gear quality may receive slightly lower weights.

Once the weights are decided, each factor's score is multiplied by its weight, and the weighted values are summed to produce a single overall score. This final score provides a clear and concise indication of performance, readiness, or risk. One key advantage of the Weighted Sum method is its transparency and interpretability. Users can easily see not only the overall score but also how each factor contributes, making it useful in applications such as decision-making, risk assessment, and recommendation systems. After calculating the final score, it can be further classified into meaningful levels such as low, moderate, or high risk in order to make the result more actionable.

While the method is simple and flexible, its accuracy depends heavily on the proper assignment of weights, which can be determined by expert knowledge or data analysis. It also assumes that factors are independent, which may not always hold true in real-life situations where factors can interact. Despite these limitations, the Weighted Sum Algorithm remains popular because it is easy to implement, computationally efficient, and provides a straightforward, explainable way to combine diverse factors.

4.2.2 Naïve Bayes Algorithm – Risk Classification and Trail Recommendation

The Naïve Bayes Algorithm is a probabilistic classification method based on Bayes' Theorem, which predicts the probability of a class based on given input features. It is termed naïve because it assumes that all features are independent of each other, even though in real-world scenarios this assumption may not always hold. Despite its simplicity, the algorithm is highly efficient and performs well in decision-making and classification tasks.

In the MyTrailMate system, this algorithm is used to classify trekkers into three distinct risk levels: Low, Moderate, or High, based on their weighted preparedness score. This score is calculated using several key factors such as fitness level, trekking experience, equipment readiness, and environmental awareness. By analyzing these variables, the algorithm determines how prepared a trekker is for different trail conditions.

The classification process works by combining prior probabilities (the general likelihood of each risk level occurring) with likelihood estimates based on the trekker's individual data to compute the posterior probability for each risk category. This relationship is mathematically expressed as:

$$P(C|X) = \frac{\{P(X|C) \cdot P(C)\}}{\{P(X)\}}$$

Where:

P(C|X) = Probability of a risk class C (e.g., High Risk) given the trekker's data X

P(X|C) = Likelihood of observing that data given the class

P(C) = Prior probability of the class

P(X) = Evidence or normalization factor

To prevent zero-probability issues when encountering unseen combinations of features, Laplace smoothing is applied. Based on the final computed probabilities, the class with the highest posterior probability is selected. For example:

- Scores above 80% are classified as Low Risk.
- Scores between 60%–80% are classified as Moderate Risk.
- Scores below 60% are classified as High Risk.

The result is then displayed to the user with clear visual cues — green for Low Risk, orange for Moderate Risk, and red for High Risk — ensuring trekkers can easily understand their safety status.

Once the risk level has been identified, the system automatically generates personalized trail recommendations. This step ensures that trekkers are guided toward trails that match their preparedness and safety needs:

- High Risk trekkers are only recommended low-difficulty trails, minimizing physical strain and exposure to challenging environments.
- Moderate Risk trekkers are shown both low and medium-difficulty trails, offering a safe yet moderately challenging trekking experience.
- Low Risk trekkers, who are well-prepared and experienced, are given access to all available trails, including high-difficulty routes involving steeper climbs and greater altitudes.

For example, a trekker with a 30% score categorized as High Risk will only see beginner-friendly routes, such as easy forest paths or flat terrain walks. A trekker with a 65% score (Moderate Risk) will see both beginner and intermediate-level trails, while someone with a score of 90% (Low Risk) will have access to all trail types, including advanced routes like high-altitude treks.

By integrating Naïve Bayes risk classification and recommendation logic into a single workflow, MyTrailMate not only evaluates a trekker's preparedness but also provides actionable guidance. This seamless combination ensures trekkers make informed, safe decisions, directly supporting the project's core mission of promoting safer and more enjoyable trekking experiences.

Chapter 5: Implementation and Testing

5.1. Implementation

Various modern tools and technologies were used during the development of the MyTrailMate application to ensure reliability, scalability, and a seamless user experience.

5.1.1 Tools Used

The following tools and technologies were used in the development of MyTrailMate – A Trekking Risk Management System:

Table 5.1:Tools and Technologies

Category	Tools / Technologies Used
Mobile App / UI/UX	React Native (with Expo)
Backend	Firebase
Location / Maps	Leaflet.js
Weather Data	OpenWeather API
Development Environment	Visual Studio Code (VS Code)
Version Control	GitHub

5.1.2 Implementation Details of Modules

Key modules implemented in MyTrailMate – A Trekking Risk Management System include:

- User Authentication Module: This module manages user registration, login, and authentication using Firebase Authentication. It ensures that each user has secure access through email and password credentials and maintains persistent sessions for convenience. By handling authentication reliably, this module forms the foundation of the app, allowing users to safely manage their profiles, track trekking history, and access personalized features without compromising security.

- Trails Management Module: The Trails Management Module is responsible for storing, updating, and displaying detailed information about trekking trails. It handles data such as trail difficulty, estimated time, terrain type, and altitude, providing users with comprehensive information for planning their treks. All trail data is managed through the Firebase Realtime Database, ensuring that the information is always up-to-date and synchronized across devices. This module plays a key role in helping users choose suitable trails according to their experience and preferences.
- Risk Score Measurement Module: This module calculates a personalized Trekking Risk Score based on multiple factors including user health inputs, selected trail difficulty, weather conditions, and recent trekking history. The calculation logic is implemented using Firebase Cloud Functions, which dynamically process the data whenever a user plans a trek. By providing a clear risk assessment, this module helps users understand their readiness, make informed decisions, and take necessary precautions before starting a trek.
- Emergency SOS Module: The Emergency SOS Module allows users to trigger an SOS alert during emergencies. When activated, the system records the user's details, current location, and timestamp in the Firebase Realtime Database. While no direct messages are sent, storing the alert ensures that emergency situations are logged and can be monitored for follow-up or rescue actions. The module uses Rule-Based Logic to manage alert handling efficiently, ensuring that no critical emergency information is lost and enhancing overall safety for users on the trail.

5.2 Testing

Testing was conducted to validate the core functionality, integration between components, responsiveness, and overall user experience. The system was evaluated through unit testing, integration testing, and system testing.

5.2.1 Test Cases for Unit Testing

Unit testing focused on verifying the functionality of individual modules and components in isolation. Key aspects tested include user registration and login, trail management, risk score calculation, SOS alert handling, and Naïve Bayes risk classification with trail recommendation.

Table 5.2: Test cases for unit testing

Test Case ID	Description	Steps	Expected Outcome	Actual Outcome	Status	Remarks
UT-01	Test user registration	Register with valid data	Redirects to assessment page	Works as expected	Pass	–
UT-02	Test user login	Login with valid credentials	Redirects to dashboard	Worked in mobile preview	Pass	Failed initially on Android via Expo
UT-03	Invalid login attempt (email)	Enter wrong email	Shows error message	Correct error shown	Pass	Only shown on Android device via Expo
UT-04	Invalid login attempt (password)	Enter wrong password	Shows error message	Correct error shown	Pass	Only shown on Android device via Expo
UT-05	Risk score calculation	Complete assessment and submit	Risk score displayed	Score generated accurately	Pass	–
UT-06	SOS alert functionality	Trigger SOS alert	Alert saved in database	Alert recorded correctly	Pass	Alerts stored only in DB, no messages sent
UT-07	Forgot password	Send password reset notification via email	Password reset email received; login works	Works as expected	Pass	–

UT-08	Naïve Bayes Risk Classification	Submit assessment data for classification	Correct risk level (Low/Moderate/High)	Risk level displayed correctly	Pass	Color-coded risk shown in UI
UT-09	Trail Recommendation	Complete assessment; view recommended trails	Correct trails displayed according to risk	Trails displayed correctly based on risk	Pass	Low/Medium/High difficulty shown correctly

5.2.2 Test Cases for Integration Testing

Integration testing verifies that multiple modules work together correctly, ensuring that user actions produce expected results across connected components.

Table 5.3: Test cases for integration testing

Test Case ID	Description	Steps	Expected Outcome	Actual Outcome	Status	Remarks
IT-01	User Auth + Risk Score Module	Login, complete risk assessment, view result	User authenticated, risk score displayed	Score shown correctly	Pass	–
IT-02	User Auth + SOS Module	Login, trigger SOS alert	User authenticated, SOS alert saved in DB	Alert recorded correctly	Pass	Alerts stored only in DB, no messages sent
IT-03	Auth + Forgot Password Flow	Request password reset, login with new password	Password reset successful, login works	Works as expected	Pass	–
IT-04	Risk Classification + Trail Recommendation	Complete assessment, view recommended trails	Correct risk level and trails displayed	Risk level and trails displayed correctly	Pass	Low/Medium/High difficulty shown correctly

5.2.3 Test Cases for System Testing

System testing ensures that the application works correctly in a real-world environment, including usability, navigation and performance. During later testing, almost all features failed when running the app on an Android device via Expo which were then resolved by using the mobile preview in VS Code.

Table 5.4: Test cases for system testing

Test Case ID	Description	Steps	Expected Outcome	Actual Outcome	Status	Remarks
ST-01	Navigation	Use navigation menu and links	Pages load smoothly	Smooth routing	Pass	–
ST-02	Form validation	Submit incomplete/ invalid data	Proper error messages displayed	Validation works	Pass	–
ST-03	Risk Assessment Flow	Complete assessment and view results	Correct risk level displayed	Risk level displayed correctly	Pass	Naïve Bayes classification verified
ST-04	Trail Recommendation	Complete assessment; view trails	Correct trails displayed based on risk	Trails displayed correctly	Pass	Low/ Medium/ High difficulty trails shown as per risk

5.3 Result and Discussions

The MyTrailMate system successfully passed all defined test cases and met its functional and usability objectives. Key observations from testing include:

1. User Authentication: This module manages user registration, login, and password recovery while validating credentials. The screenshots below show successful operations and password reset, confirming the system works as expected.

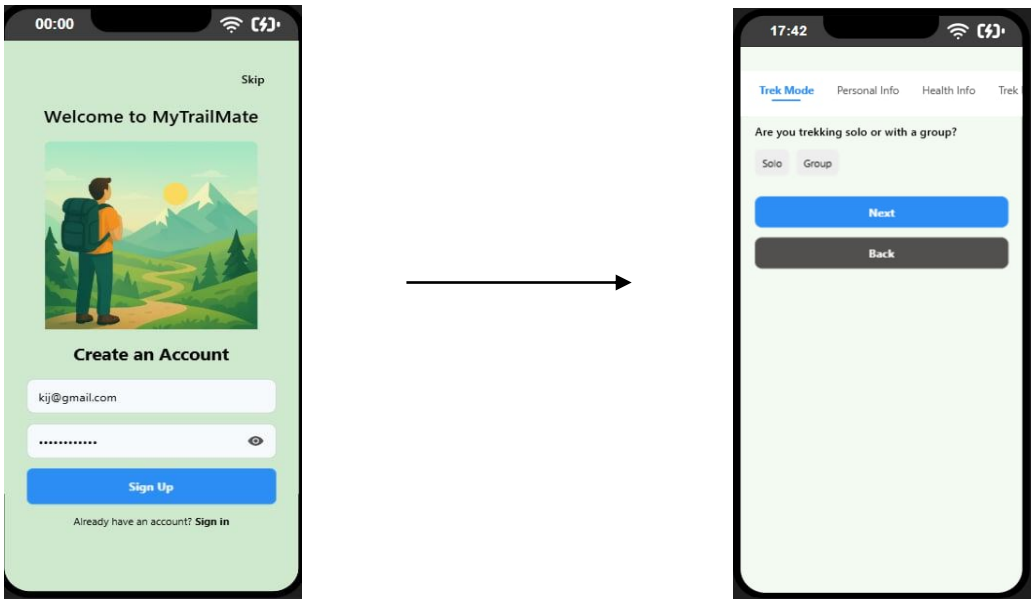

Figure 5.1: Successful new user Authentication

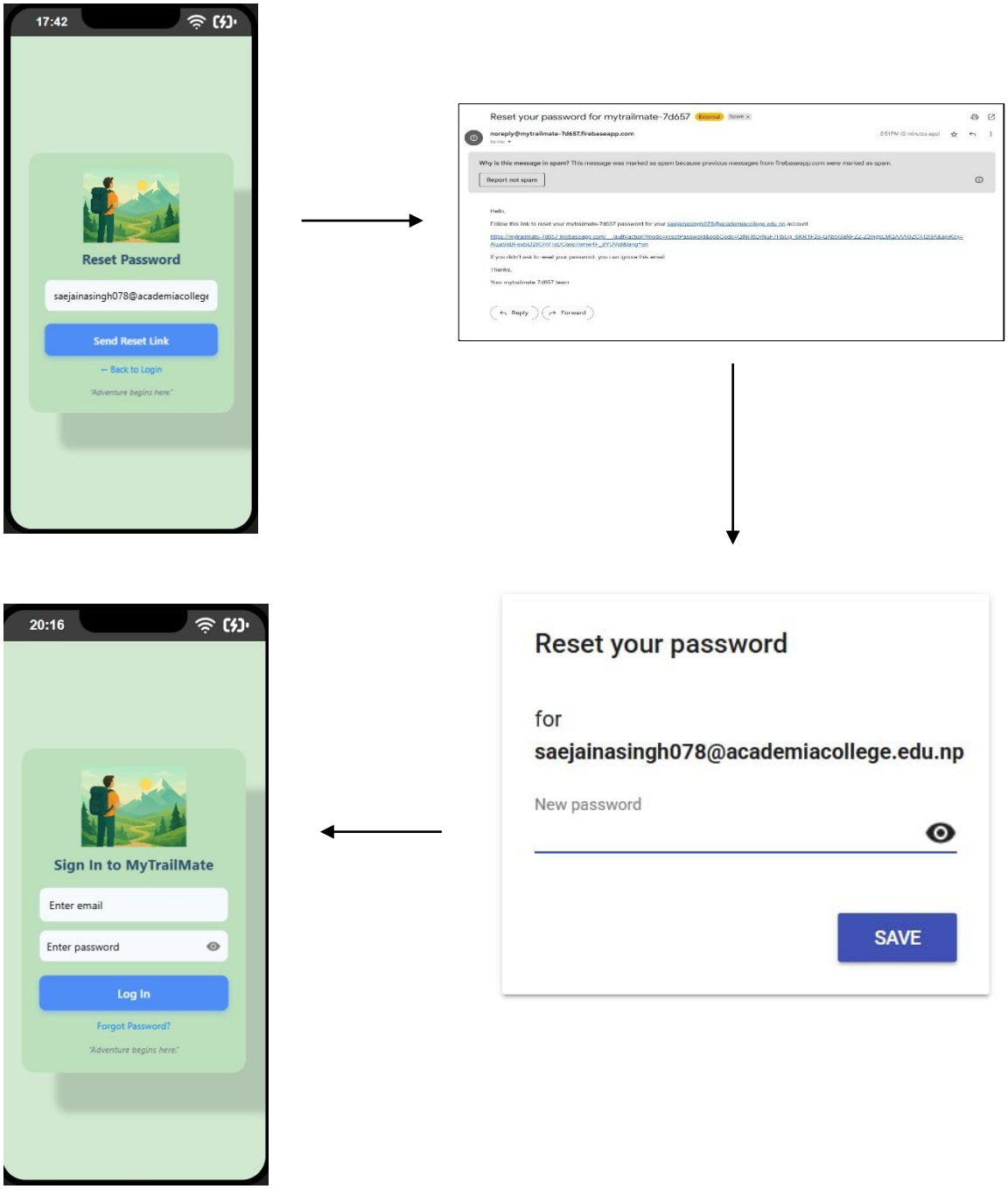

Figure 5.2: Successful password reset

2. Risk score Calculation: The system calculates a user's risk score by combining multiple factors using the Weighted Sum algorithm. This ensures personalized and reliable risk assessment for each user.

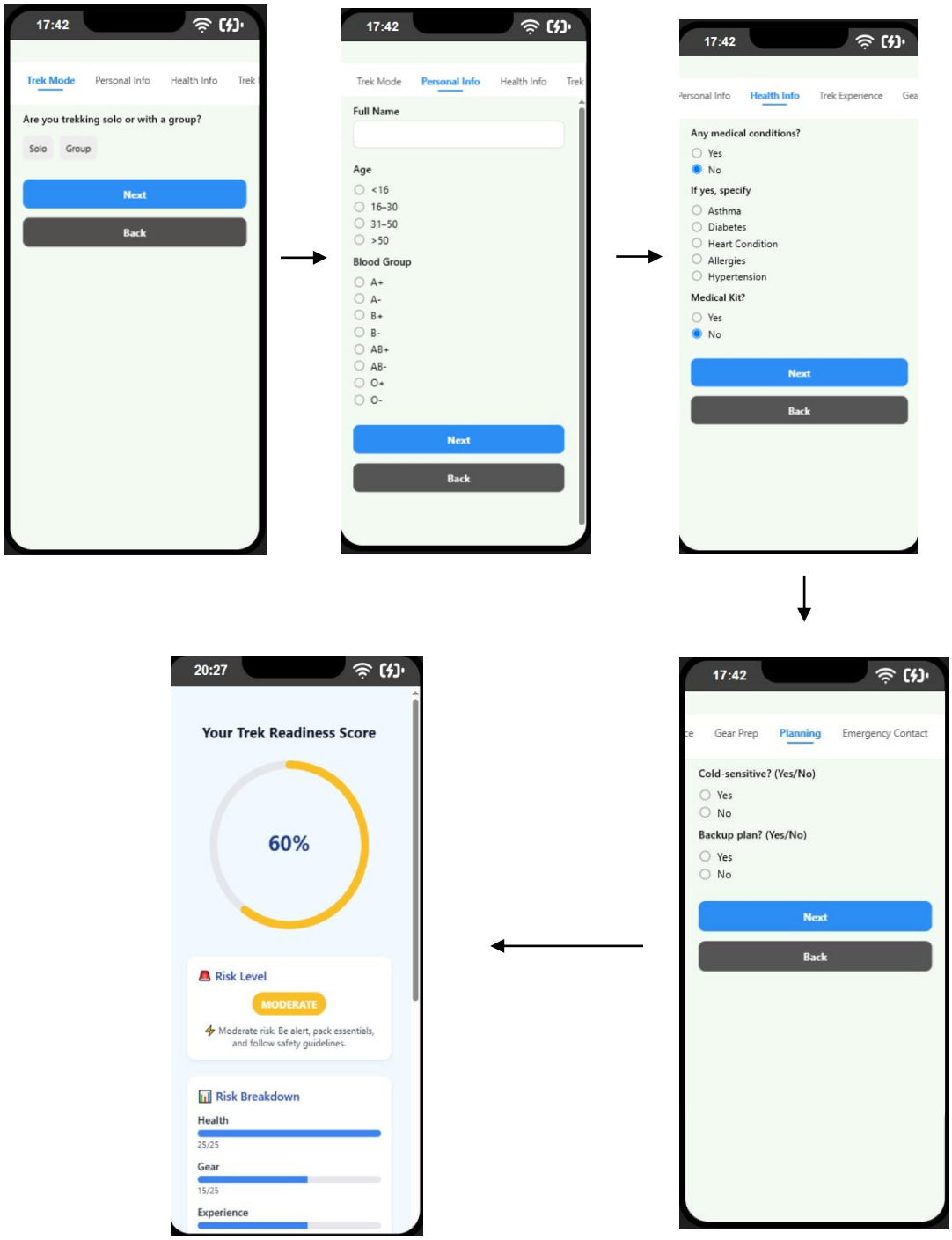

Figure 5.3: Successful risk score calculation

3. SOS Alert Handling: The SOS feature manages emergency situations by sending immediate alerts with the user's location to designated contacts. This ensures timely assistance and enhances user safety during critical events.

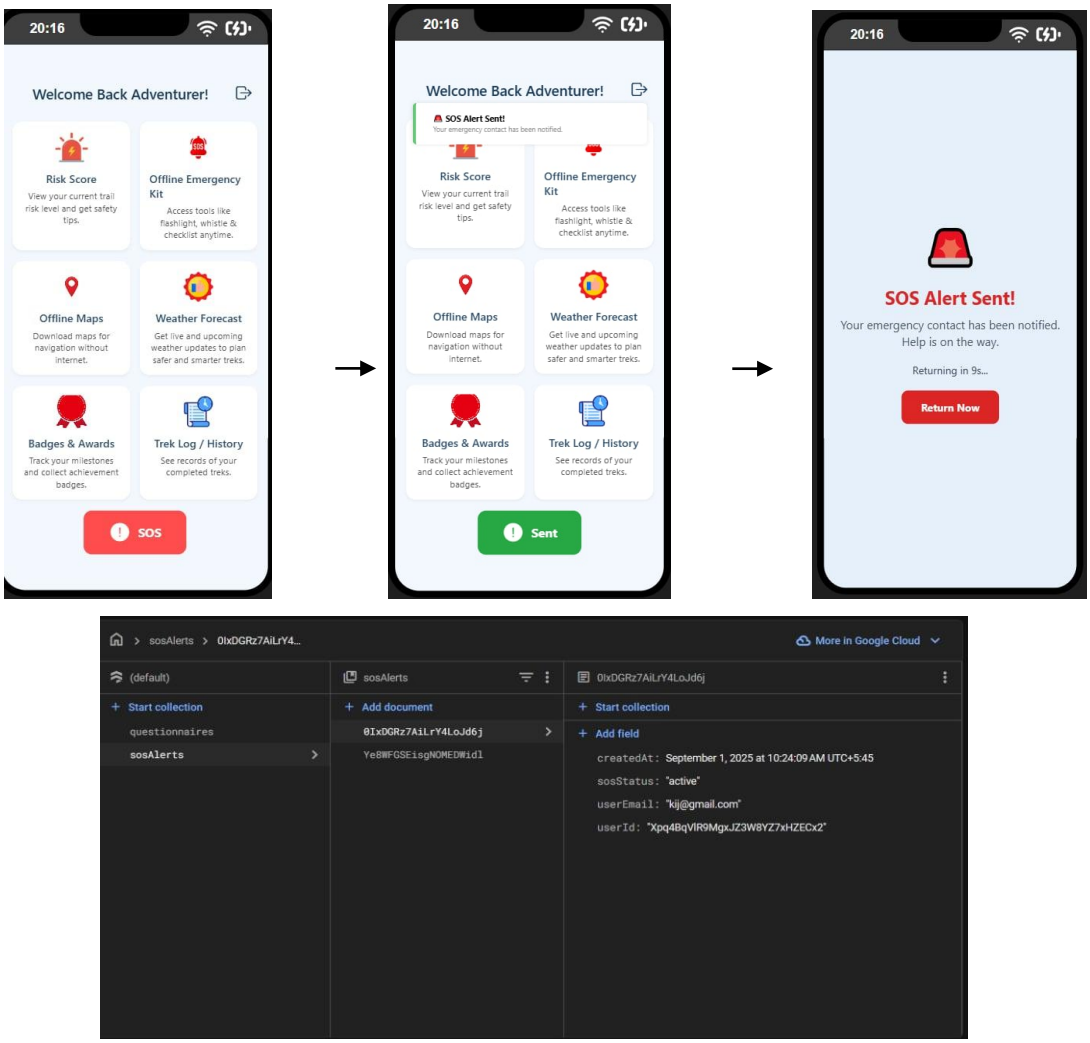

Figure 5.4: Successful storage of data of the alerted SOS

4. Naïve Bayes Risk Classification & Trail Recommendation: The MyTrailMate system uses the Naïve Bayes algorithm to classify users into Low, Moderate, or High risk levels, displayed with color-coded indicators. This classification guides personalized trail recommendations: high-risk users get low-difficulty trails, moderate-risk users get low and medium trails, and low-risk users can access all trails. This ensures trekkers are matched to trails suited to their preparedness, promoting safety and informed decision-making.

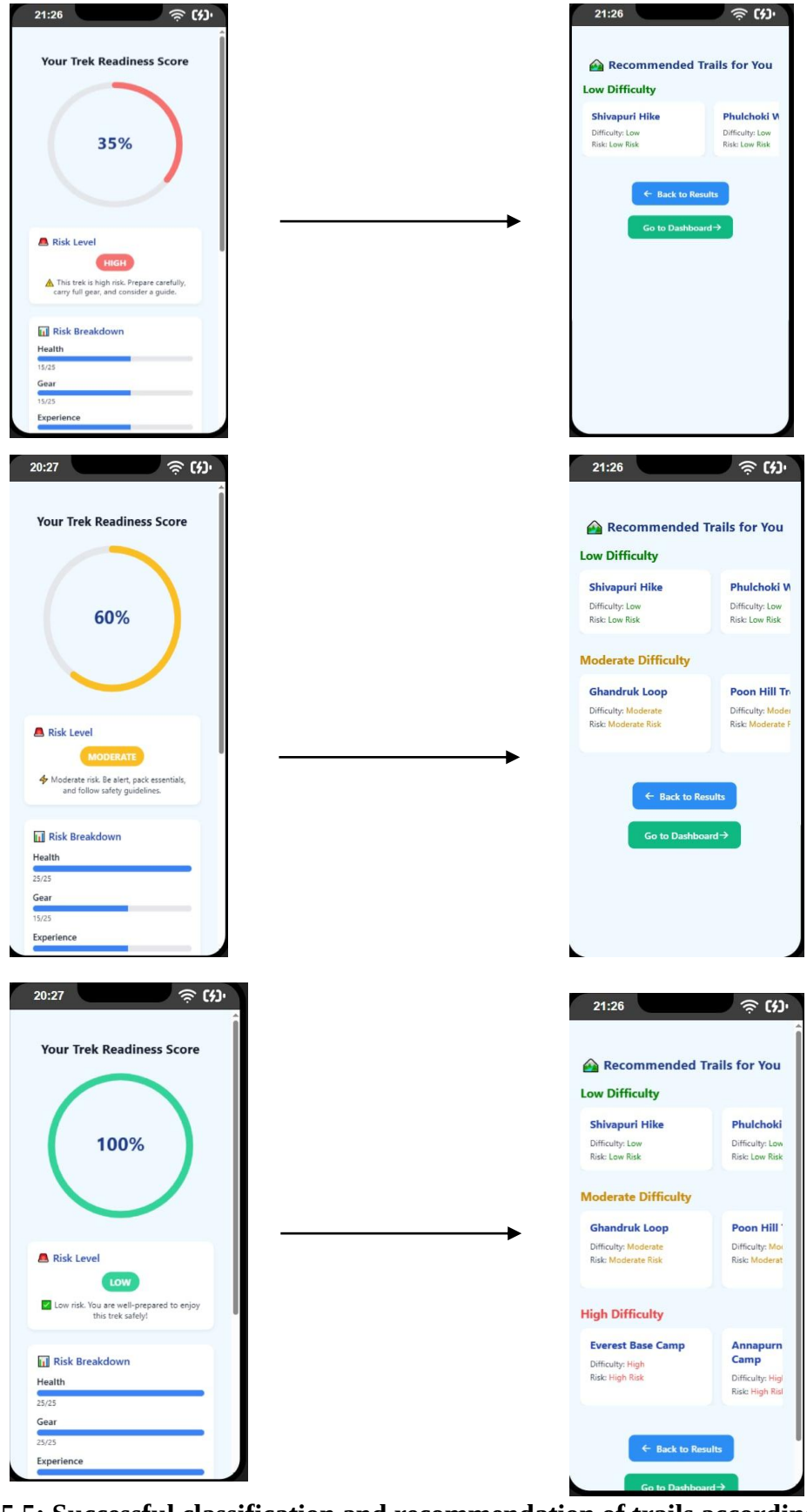

Figure 5.5: Successful classification and recommendation of trails according to the risk score

5. Form Validation & Error Handling: The system incorporates comprehensive validation to ensure data integrity. Both client-side and backend checks prevent users from submitting incomplete or incorrectly formatted information. Clear error messages guide users to correct mistakes, reducing the risk of invalid data entering the system and enhancing overall reliability.

6. Navigation and Usability**:** The application offers smooth and consistent page transitions, allowing users to move seamlessly between dashboard, risk assessment, trails, and SOS screens. The layout is responsive and mobile-friendly, with readable text and properly scaled elements. This ensures intuitive navigation, improves user experience, and confirms that the interface is accessible across different devices.

Chapter 6. Conclusion and Future Recommendations

6.1 Conclusion

The development of the MyTrailMate – Trekking Risk Management System represents an important step toward improving safety, preparedness, and overall trekking experience. By combining mobile technologies with cloud-based services and real-time data, the system provides key features such as user authentication, trail information, personalized risk score calculation, and SOS emergency alerts. The risk score module, based on the Weighted Sum algorithm, allows users to assess their readiness for specific treks using personal and environmental factors, adding significant value to the app. The system demonstrated stable performance, responsiveness across devices, and accurate functionality of all core modules during testing. With an intuitive interface, smooth navigation, and emergency support tools, MyTrailMate effectively addresses both preventive and reactive safety needs, making it a practical and reliable tool for trekkers, particularly in remote or high-risk trails. Overall, the system meets its primary objectives and provides a solid foundation for future enhancements.

6.2 Future Recommendations

- Integrate a personalized trail recommendation system to suggest trails based on user history, preferences, and risk assessment.
- Enable users to update and manage their profiles to improve personalization and tracking of trekking performance and safety data.
- Enhance the SOS feature to ensure alert messages are reliably sent to multiple emergency contacts with the user’s real-time location for faster response in critical situations.

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Appendices

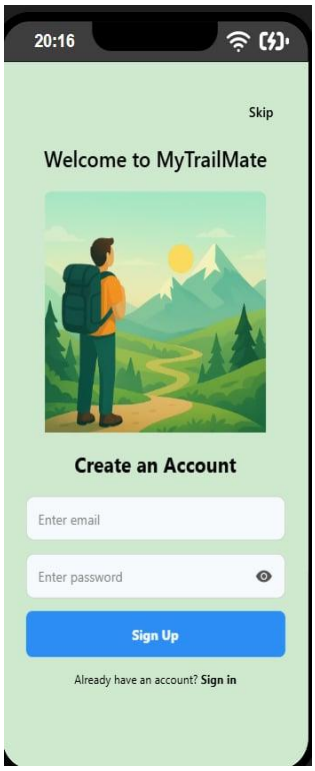


Figure - 1 :Welcome Page

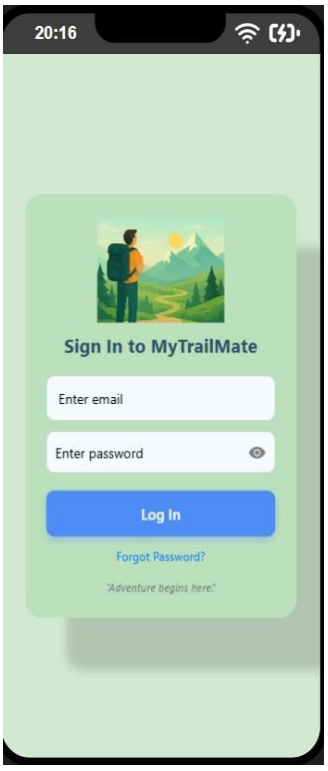


Figure - 2:Login Page

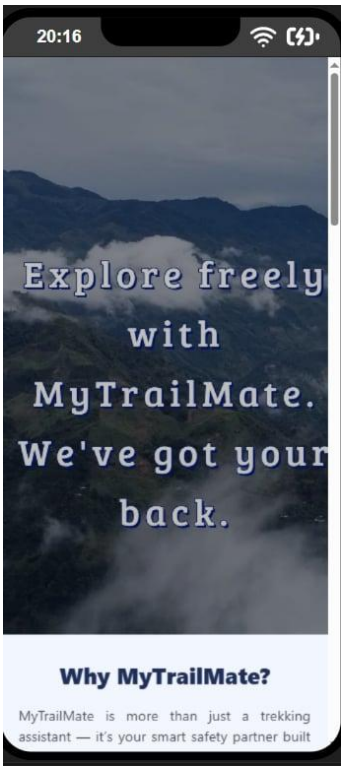
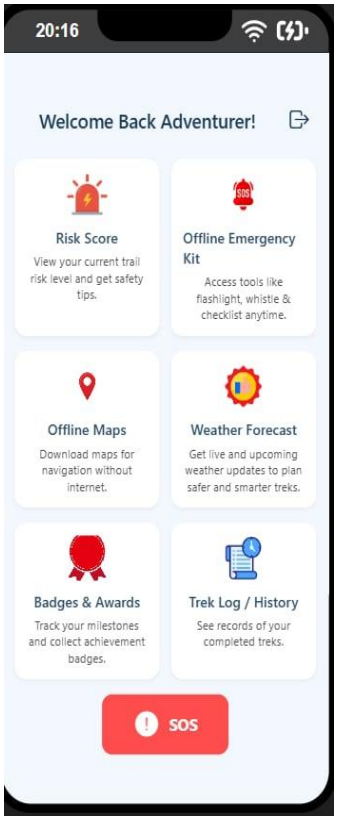
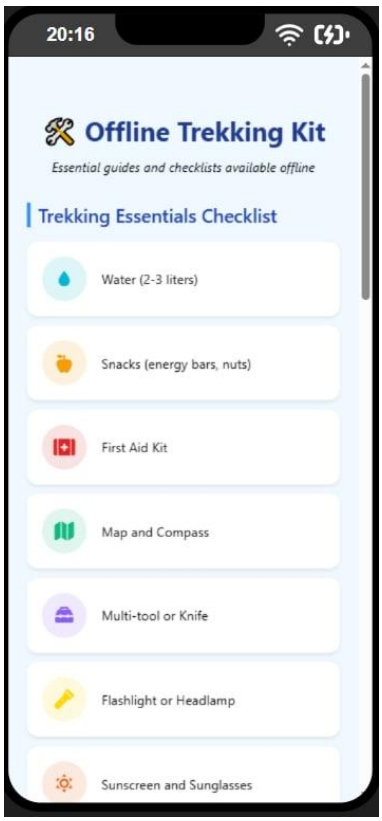
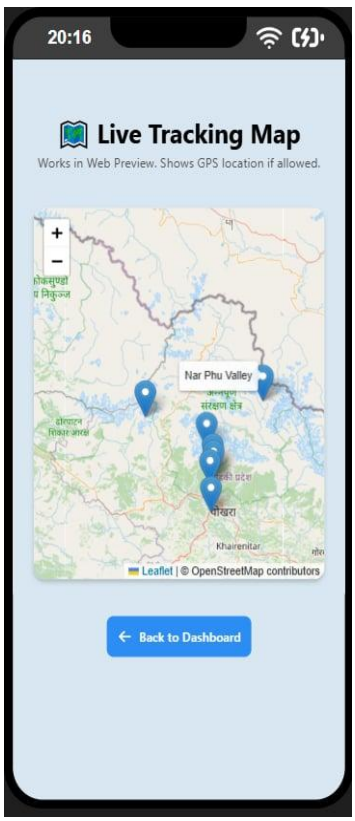


Figure - 3: About us Page







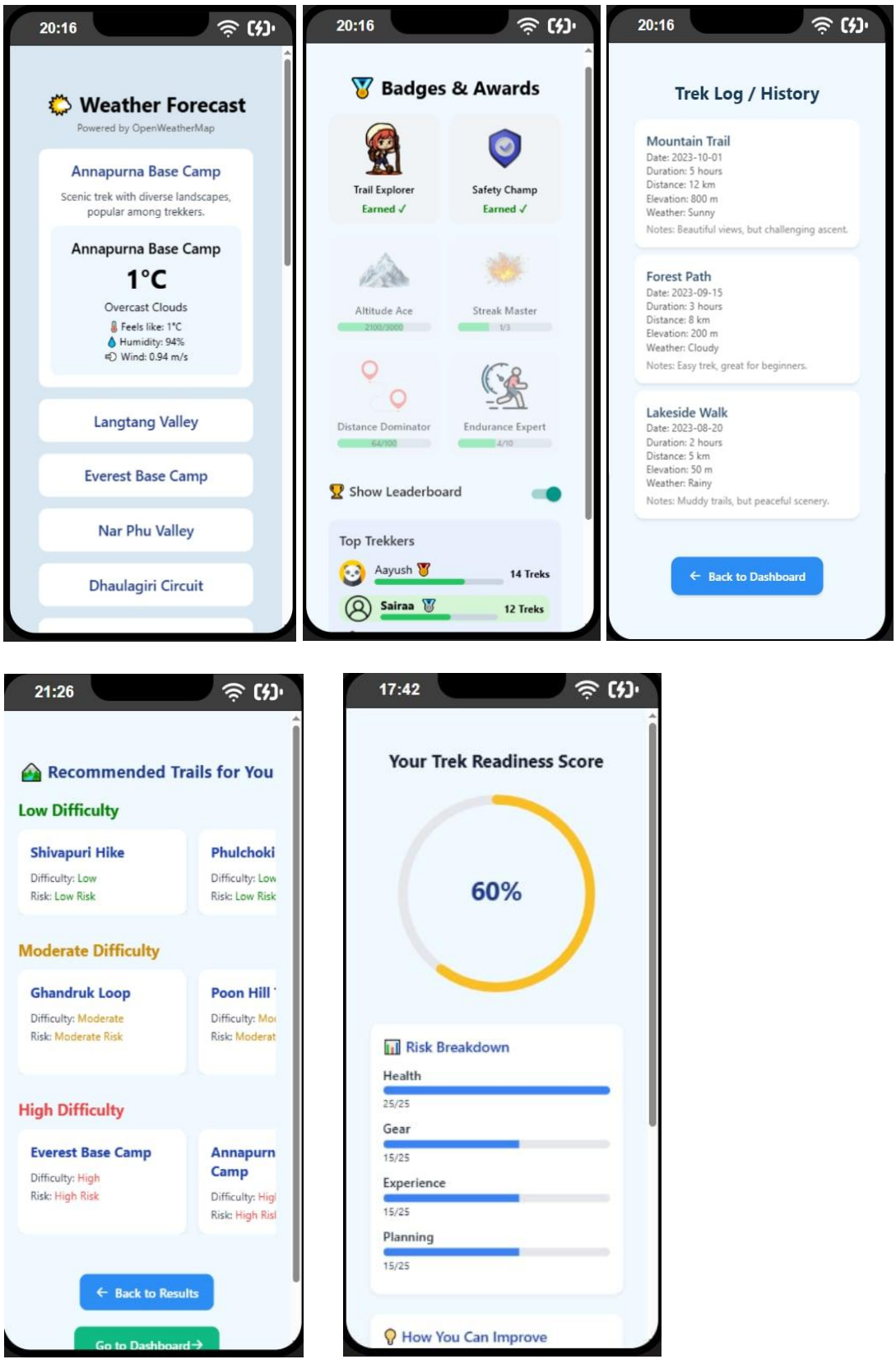


Figure – 4: Features of dashboard

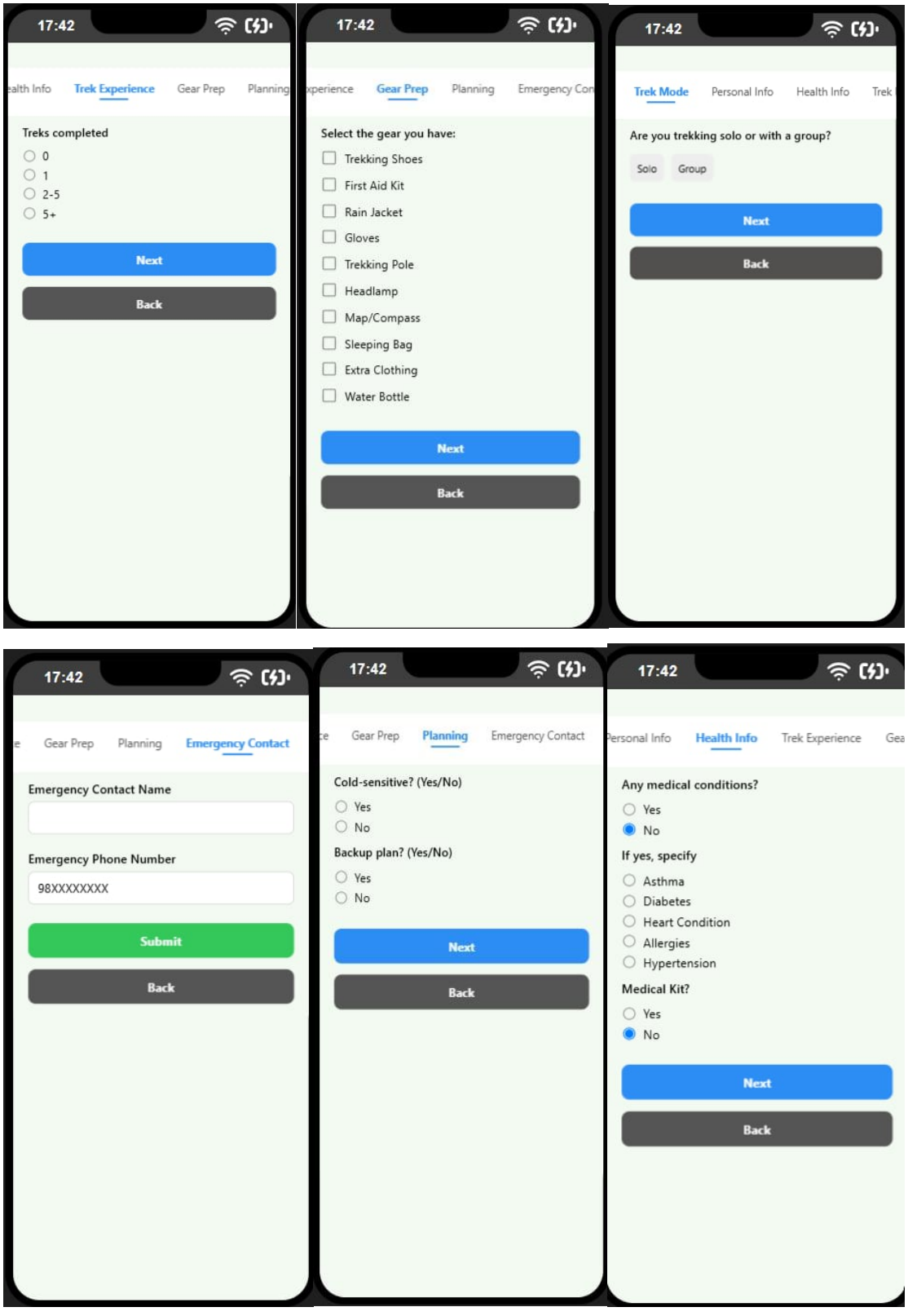


Figure - 5: Set of Questionnaire