

CHAPTER 2. SOFTWARE REQUIREMENTS

2.1 Tools and Technology

The development of the NutriCall mobile application involves the integration of a variety of advanced tools and technologies, all aimed at creating a seamless user experience. By prioritizing efficiency, scalability, and user-friendliness. NutriCall focuses on key features such as generating recipes, conducting thorough nutritional analyses, and providing a robust food tracking system.

2.1.1 Android Studio

Android Studio is the main Integrated Development Environment (IDE) used in developing the NutriCall application. As the official IDE recommended by Google for Android development, Android Studio provides a variety of advanced features that support the entire application creation process, from writing code, designing user interfaces, testing, to deploying to Android devices.

One of the main advantages of Android Studio is its ability to provide real-time code analysis, which helps developers identify errors or potential problems early on. The advanced code auto-completion feature and refactoring capabilities speed up the development process and make it easier to maintain code in the long term, especially in complex applications such as NutriCall which have many features and modules.

Android Studio is also equipped with a visual Layout Editor and Preview Panel, which allow developers to design user interfaces (UI) with an XML-based approach efficiently and interactively. This makes it easy to create consistent and responsive designs across various screen sizes and Android devices. The built-in Android emulator provides cross-device and operating system testing capabilities, allowing debugging and interface verification to be carried out without a physical device directly.

2.1.2 Kotlin

The core programming language used to develop NutriCall is Kotlin. This language was developed by JetBrains and is officially supported by Google as the first choice language for Android development. The selection of Kotlin in this project was based on a number of technical and functional advantages that make it highly relevant for building modern, scalable and efficient mobile applications.

One of Kotlin's main advantages is its full interoperability with Java, which allows the integration of existing libraries and frameworks without the need for major migrations. With its

concise, expressive, and modern syntax, Kotlin minimizes boilerplate code, increasing developer productivity and facilitating the debugging and long-term maintenance process.

The null safety feature in Kotlin provides additional assurance in preventing common errors such as `NullPointerException`, which has often been a source of Android application crashes in the past. With an explicit nullable and non-nullable handling system, developers can ensure that each variable is managed with strict type control.

Additionally, Kotlin supports the functional programming paradigm through features such as extension functions, higher-order functions, and lambda expressions, which facilitate writing more modular, declarative, and testable code. In the context of the NutriCall application, this approach is used in managing the user interface (UI), validating input data, and manipulating complex data structures retrieved from APIs or Firebase Firestore.

Kotlin's native support for coroutines is a crucial aspect in developing applications that rely on a lot of asynchronous operations, such as data requests from the Gemini AI API, communicating with Firestore, and other network interactions. With coroutines, NutriCall can handle asynchronous processes efficiently without blocking the main thread, maintaining the application's responsiveness even in slow or unstable network situations.

2.1.3 Gemini AI

Gemini AI, an artificial intelligence based on natural language processing (NLP), is the core of the NutriCall application development. This AI technology is integrated into the system through the Application Programming Interface (API) service provided by Gemini, which allows the application to interact two-way with intelligent generative language models to produce dynamic and contextual content according to user needs. In the context of the NutriCall application, Gemini AI is used to perform three main functions: (1) generating recipes based on the list of ingredients selected by the user, (2) generating recipes based on the target number of calories entered by the user, and (3) answering user questions related to nutrition and diet through the AI Messages feature. This process is carried out by sending a request (prompt) to the Gemini API via the HTTP protocol using the Retrofit library integrated with Kotlin Coroutines so that communication takes place asynchronously without disrupting the performance of the user interface. Gemini then responds with results in the form of text that has been analyzed and arranged in a recipe format, including the name of the food, the steps to make it, and the estimated nutritional value (such as calories, protein, carbohydrates, fiber, and fat).

To overcome geographical limitations in accessing Gemini services (for example, in China), the NutriCall application uses an indirect architectural approach through a proxy server deployed using a third-party service such as Railway.app. This server is tasked with receiving requests from mobile applications, forwarding them to the Gemini API, and then returning the results to the application. This approach also increases security by hiding the API key from the client side.

2.1.4 Retrofit Libraries

Retrofit is a REST-based HTTP client library used in the NutriCall application to handle communication between Android applications and external API services, including Gemini AI. Developed by Square, Retrofit provides an efficient and easy-to-use interface for making network requests (HTTP requests), while automatically processing the responses into Kotlin objects through the use of converters such as Gson or Moshi.

In the context of the NutriCall application, Retrofit serves as the main bridge between the presentation layer and the backend services. For example, when a user inputs food ingredients or a calorie-based diet request, Retrofit is used to send a POST request to a server connected to Gemini AI, and then handles the returned response in JSON format. The data is then transformed into Kotlin data structures that can be directly displayed on the user interface or further processed by the ViewModel.

One of Retrofit's main strengths is its ability to abstract and simplify API calls. With annotations such as `@GET`, `@POST`, `@Query`, and `@Body`, Retrofit allows developers to design declarative and easy-to-read network service interfaces. This minimizes the risk of errors in writing network code and improves the overall readability and maintainability of the source code.

In addition, Retrofit supports managing callbacks and suspending functions using Kotlin coroutines, thus supporting asynchronous programming in a safer and more efficient way. This is very important in maintaining the performance of the NutriCall application, especially when there are repeated requests in a short time or when operating on an unstable network.

The additional features offered by Retrofit also greatly support the needs of modern mobile applications. Retrofit can be combined with OkHttpClient for advanced configurations, such as adding interceptors for logging, token authentication, retry mechanisms, and response caching. In the NutriCall project, this helps ensure that data communication remains fast, secure, and reliable, while reducing the burden on the network when data can be reused from the cache.

2.1.5 Postman

Postman is one of the main tools used during the development and testing of API integration in the NutriCall application. As a popular Application Programming Interface (API) testing platform among software developers, Postman provides a comprehensive working environment for designing, testing, documenting, and managing API interactions efficiently. In the context of NutriCall, Postman is an essential tool for ensuring that communication between mobile applications and external services such as Gemini AI servers is correct, consistent, and as expected.

One of Postman's main strengths is its ability to compose and send various types of HTTP requests (such as GET, POST, PUT, DELETE) to API endpoints, complete with headers, parameters, bodies, and authentication settings. NutriCall developers use Postman to test and verify that the server's response to user requests—for example, a request to generate calorie-based recipes via Gemini AI that provides data in the appropriate format, such as JSON that can be parsed by the Android application.

2.1.6 Firebase

Firebase plays a very important role for the backend and storage of the NutriCall application because this platform offers various Backend-as-a-Service (BaaS) services that support user authentication, database management, and real-time data synchronization. Moreover, Firebase has the advantage of its reliable ability to provide a secure, scalable, and easy-to-integrate cloud infrastructure, thus accelerating the development process while maintaining application stability.

In its implementation, NutriCall uses Firebase Authentication to handle the user login process with various methods, including using email and password. In addition, NutriCall utilizes Firebase Cloud Firestore, a cloud-based NoSQL database that allows real-time data storage and retrieval. Firestore is used to store various types of data such as user information in the `users` database, saved recipes and their categories `saved_recipes`, food images from website scraping `recipes_images` and daily consumption history records `nutrition_records`. Firestore supports data replication between mobile phone devices and instant data updates, thus ensuring the consistency of user data.

2.2 Functional Requirements

2.2.1 Authentication and Authorization

NutriCall implements a secure and integrated authentication and authorization system using Firebase Authentication to manage user identity. This system allows users to register for a new account by entering important information such as email, password, username, date of birth, weight, and height. After successfully registering, users can log in to the application with these credentials and access personalized features. To ensure security and convenience, NutriCall also provides a password reset feature, so users can restore access if they forget their password. After logging in, users can manage their personal information through the profile page, including updating health data such as age, weight, and height. Any changes made will automatically update the calculation of biometric data such as Body Mass Index (BMI) and Total Daily Energy Expenditure (TDEE). Thus, NutriCall's authentication and authorization system not only serves as an access gateway, but also as a foundation for ongoing personalized services, supporting the accuracy and relevance of nutritional recommendations provided to users.

2.2.2 Recipe Search

The Recipe Search feature in the NutriCall app is designed to help users find foods that suit their dietary needs more flexibly and efficiently. Users can search by recipe name, select specific ingredients, or set calorie restrictions through interactive filters such as SeekBar. Each recipe displayed in the search results is accompanied by real-time nutritional information obtained through integration with Gemini AI API, including estimated calories and macronutrient content such as carbohydrates, protein, and fat. In addition to text-based and ingredient-based searches, users can also save and categorize recipes into a favorites list for future reference. The system is designed with a dynamic data loading architecture and a responsive UI grid, allowing search results to be displayed quickly under various network conditions. All of these search and save features are seamlessly integrated into the Save Fragment, providing quick access to saved or categorized recipes. With this approach, NutriCall supports a personalized, intuitive user experience that is adaptive to each individual's nutritional preferences and needs.

2.2.3 Nutritional Analysis

NutriCall provides a sophisticated Nutrition Analysis feature to help users understand their food intake accurately and efficiently. This feature is directly integrated with Gemini AI,

which is able to perform real-time nutritional analysis on recipes selected by users. When users open the recipe detail page and press the Create button, the application will send the recipe data to Gemini AI to generate nutritional information, including the number of calories and the content of key macronutrients such as carbohydrates, proteins, and fats.

The results of this analysis are then automatically recorded and stored by the application as the user's daily nutritional data, without the need for manual input. The information is dynamically updated, so that users get a clear picture of the calories and nutritional value consumed from the recipe. In addition, NutriCall allows users to manually adjust or delete nutritional entries if necessary, so that users have full control over their intake data. This feature is designed to provide precise and practical nutritional insights, supporting users in making more informed dietary decisions and making it easier to monitor daily food consumption.

2.2.4 Health Tracking & History

Health tracking is a core feature of NutriCall that focuses on supporting users' long-term health. The app automatically keeps a historical record of daily calorie intake based on food data recorded during user interactions with recipes and food logging features. This consumption history allows users to continuously monitor their eating patterns and nutritional behaviors, while measuring progress and achievement of health goals over time. Integration with Gemini AI strengthens this feature by providing consistent and accurate nutrition data analysis. Based on this data, NutriCall generates personalized progress reports, which help users identify areas for improvement and successes in their diet routine. This feature supports better decision-making and motivation to maintain a healthy lifestyle.

2.2.5 BMI Counting

The BMI Calculation feature in NutriCall allows users to calculate their Body Mass Index (BMI) based on their height and weight. This feature helps users assess their body composition and receive relevant nutritional recommendations. The app calculates BMI automatically every time a user updates their height and weight in their profile. Users enter their weight (kg) and height (cm), and the app calculates BMI using the formula:

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height(m)}^2}$$

NutriCall classifies users into several known health categories, such as Underweight, Normal, Overweight, or Obese. This classification guides subsequent nutrition

recommendations, such as daily calorie adjustments and dietary advice. Furthermore, BMI data is stored persistently in Firebase Firestore, allowing users to track fluctuations in their health metrics and observe the impact of lifestyle changes over time.

2.2.6 AI Messages

The AI Messages feature in NutriCall is designed to provide personalized nutrition guidance and health insights through an interactive chat system within the app's Message Fragment. The feature allows users to engage in real-time conversations with an AI-powered assistant, helping them make informed dietary decisions based on their nutritional goals and health status. Users can engage in dynamic conversations with the AI assistant to get advice on calorie intake, ingredient substitutions, and meal planning tailored to their BMI, and TDEE values. The assistant is also capable of creating custom meal plans or suggesting recipes that suit the user's dietary preferences and health goals. Additionally, the AI can evaluate historical diet data to provide insights and trend reports on calorie intake and nutrient balance. This conversational interface mimics the experience of talking to a nutritionist, making personalized diet planning more accessible and engaging.

2.2.7 User Profile

NutriCall features a comprehensive User Profile feature as a central point for managing user data and preferences. Through this feature, users can access and edit their basic information such as full name, email address, and password with strict security validation mechanisms to protect personal data and ensure secure account access. In addition, users can dynamically update important health data, including age, weight, and height. These data updates automatically trigger recalculation of key health indicators such as Body Mass Index (BMI) and Total Daily Energy Expenditure (TDEE) that form the basis for personalized nutrition advice and diet planning in the app.

This feature also supports profile picture management, allowing users to upload, update, or delete their profile picture with an optimized image handling process that does not burden the app's performance. All changes made to the user profile are immediately synced in real-time with the backend using Firebase, specifically Firebase Cloud Firestore and Firebase Storage, to maintain data consistency and security across sessions and devices. This approach ensures a seamless and responsive user experience, and makes it easy for users to keep their health data and preferences up-to-date quickly and securely.

2.2.8 Save Recipe

The Save Recipe functionality makes it easy for users to save and manage their favorite recipes efficiently through the Save Fragment interface. Users can bookmark or delete recipes with a single tap directly from the recipe detail page, making the saving process extremely convenient and fast. Saved recipes are then automatically categorized by specific types, such as low-calorie, high-protein, or vegetarian, making it easy for users to navigate and organize their recipe collection according to their dietary preferences and nutritional needs.

All bookmarked recipe data is stored persistently in Firebase Cloud Firestore, ensuring that user preferences are protected and consistently accessible across devices and sessions, even after users log out or switch devices. The use of Firebase also enables real-time data sync, so any changes to the list of saved recipes are immediately reflected in the app without any delay. With this feature, NutriCall increases user engagement by providing easy access to personalized meal plans, while reducing the time and effort required to repeatedly search for favorite recipes..

2.3 Non-Functional Requirements

2.3.1 Performance

NutriCall is designed to provide a smooth, fast, and responsive user experience, in order to maintain user satisfaction and comfort in interacting with the application. To that end, the system is targeted to be able to respond to every user action such as saving recipe data or profiles, and updating health information with in a maximum of 2seconds.

To meet this response time target, NutriCall implements various optimization techniques, including:

- Caching: Frequently accessed data, such as a list of popular recipes or user information, is temporarily stored in a local cache to reduce the burden of repeatedly retrieving data from the server or database.
- Efficient database queries: Query structures are optimized to speed up data retrieval and storage, using proper indexing and data management on Firebase Firestore.
- Asynchronous Processing: Heavy operations such as communicating with Gemini AI to retrieve nutritional data are performed asynchronously on a background thread, so as not to disrupt the smoothness of the user interface (UI) and to keep the UI responsive.

In addition, the process of retrieving and processing recipes generated by Gemini AI via the API must be completed and displayed to the user in less than 10 seconds. This is

important so that users do not experience long delays while waiting for the results of nutritional recommendations or personalized recipes.

2.3.2 Security

Security is a key aspect of NutriCall's design to protect user data and privacy across the board. The authentication system uses Firebase Authentication, which secures the login process by encrypting passwords, preventing unauthorized access. Sensitive user data, including personal information such as age, weight, height, and dietary preferences, is stored securely in Firebase Firestore with strict Firebase Security Rules enforced. These rules govern user access rights so that only authorized users can access specific data. Additionally, all data communication between the app and the server is done over the HTTPS protocol, ensuring encrypted data transmission and is safe from potential eavesdropping or manipulation during transit. With this approach, NutriCall ensures that user data is kept secure.

2.3.3 Usability

NutriCall is designed with an intuitive and easy-to-use interface, so that it can be enjoyed by users of all levels of technological ability, from beginners to more advanced users. The application adopts a modern and consistent Material Design principle, which not only ensures clear and logical navigation, but also creates a clean and aesthetic layout that makes users feel comfortable when interacting. Each element in the application is structured to facilitate easy access to key features such as recipe search, nutritional analysis, and user profile management. Nutrition information is presented in an informative and easy-to-understand manner, this presentation helps users quickly understand their nutritional status without having to analyze complex data. With a design approach that focuses on convenience and ease, NutriCall ensures a pleasant and effective user experience in achieving their health goals.

2.3.4 Maintainability & Reliability Requirements

NutriCall is built with a modular architecture that implements the MVVM (Model-View-ViewModel) design pattern, which significantly simplifies the application maintenance process and accelerates the addition of new features or future updates. This approach separates business logic from the user interface, allowing developers to manage code in a more structured and efficient manner. To ensure reliability, NutriCall is designed to have an uptime rate of 99.9%, fully supported by the Firebase cloud infrastructure which is known for its stability and

scalability. User data is automatically backed up every day to prevent data loss and provide a disaster recovery mechanism in case of disruption. In addition, the application is integrated with monitoring tools such as Firebase Crashlytics and performance monitoring, which enable real-time bug detection and handling, so that the quality of the application is maintained.

2.3.5 Error Handling & Recovery

NutriCall is designed to handle errors in a structured and user-friendly manner to ensure a smooth user experience even when issues occur. When errors such as internet connection failure, request failure to Gemini AI API, or data saving error to Firebase occur, the app displays a clear and informative notification message to the user, such as “Failed to load data, try again later” or “Unable to save recipe, check your internet connection.” In addition, the app automatically logs errors using integration with Firebase Crashlytics, allowing the development team to quickly monitor, analyze, and fix bugs without disrupting users.

