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JOMO KENYATTA UNIVERSITY

OF

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IT DEPARTMENT

FINAL YEAR RESEARCH PROJECT

Design and Development of an AI Powered Workout Application for Personalized Fitness Engagement

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A final report submitted to the Department of Information Technology in the School of Computing and Information Technology in partial fulfillment of the requirement for the award of the degree of Bachelor of Science in Information Technology at Jomo Kenyatta University of Agriculture and Technology.

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Declaration

Candidate's Declaration

This proposal/research project is my original work and has not been presented for a degree in any other University.

……jonathan……12/12/2024

This research project has been submitted for examination with my approval as University Supervisor

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Abstract

The growing adoption of fitness applications is reshaping the landscape of personal health and wellness. This project proposes the design and development of an AI and ARpowered workout application aimed at enhancing user engagement, motivation, and personalized fitness tracking. The application will leverage artificial intelligence for adaptive workout recommendations and exercise tracking.

The proposed solution incorporates a hybrid recommendation model combining collaborative filtering and deep learning to suggest workouts based on user preferences and performance. Additionally, AR technology will be utilized to guide users through exercises, providing real-time visual feedback. The backend system, built using Django, will manage data storage and serve API requests to the cross-platform Flutter frontend.

The research methodology involves iterative prototyping, user-centered design, and integration testing. User data will be securely processed and analyzed to enhance personalization while adhering to privacy standards. Expected outcomes include improved user adherence to workout plans, higher engagement through gamified AR features, and actionable insights from visual analytics.

This project seeks to bridge existing gaps in AI integration in fitness applications and deliver a feature-rich platform that adapts to diverse user needs, contributing significantly to the domain of digital health technologies.

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Acronyms

WHO ---------- World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Background

The global fitness industry has experienced tremendous growth over the past decade, driven by the increased awareness of the importance of physical activity. According to reports by the World Health Organization (WHO), physical inactivity is one of the leading risk factors for global mortality through noncommunicable diseases like heart disease, hypertension, stroke, diabetes and several cancers. ("Physical activity." *World Health Organization (WHO)*, 26 June 2024).

Consequently, there has been an upward trend in the use of technology to assist individuals in achieving their fitness goals. The global fitness app market size was valued at USD 9.25 billion in 2023 and is projected to grow at a compound annual growth rate (CAGR) of 14.08% from 2024 to 2030. COVID-19 pandemic resulted in nationwide lockdowns and subsequent adoption of social distancing measures ("Fitness App Market Size & Trends" *World Health Organization (WHO)*, 26 June 2024). With mobile applications gaining widespread adoption as a tool for personal health tracking and workout guidance.

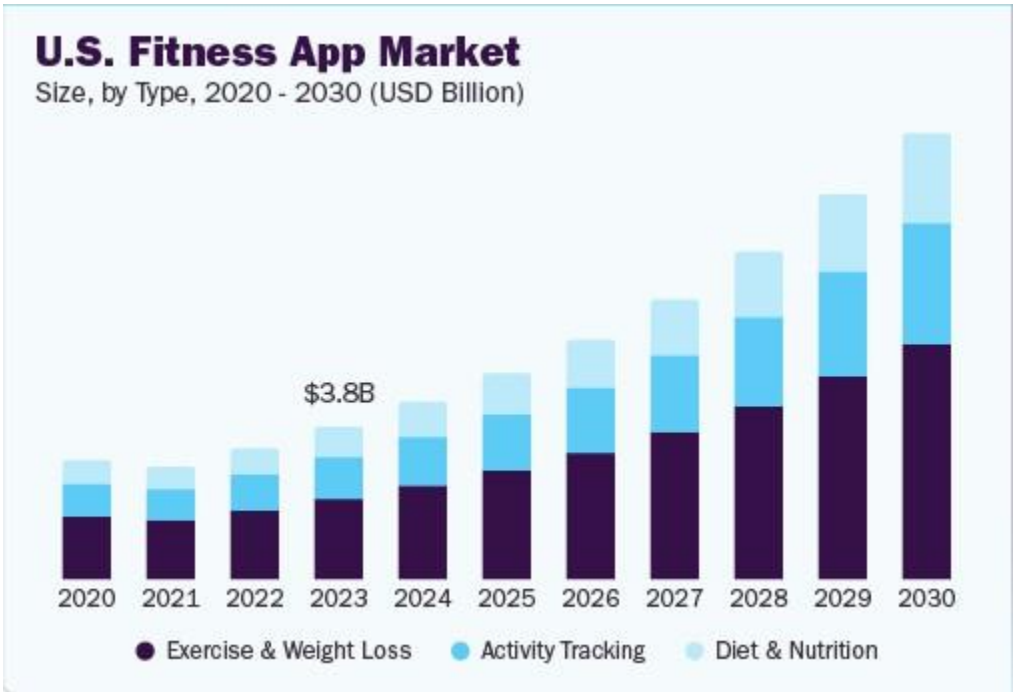

Figure 1: US Fitness App Market

Locally, in Kenya, fitness culture is also gaining popularity, with an increase in the number of gyms, personal trainers, and fitness enthusiasts. However, many fitness apps on the market are generalized and fail to cater to the specific needs of users, particularly in emerging markets where access to advanced fitness technology is limited. There is also a gap in integrating local needs such as affordability and user-friendly interfaces for non-expert users. Thus, there is an opportunity to develop a tailored workout application that leverages AI and exercise tracking to motivate and guide users in achieving their fitness goals.

1.2 Project Overview

This project focuses on developing a mobile application that integrates various advanced technologies, such as Artificial Intelligence (AI), and fitness tracking, to enhance user experience in managing and improving their fitness routines. Globally, AI is transforming the fitness industry by personalizing workout plans.

The proposed workout application will utilize AI to analyze user data and provide personalized workout routines, while comprehensive exercise tracking will monitor user

performance and provide actionable feedback. In Kenya, the need for accessible fitness tools is evident, as more people seek to incorporate fitness into their daily lives despite limited access to professional guidance. This app will bridge that gap, providing a costeffective and comprehensive fitness solution.

1.3 Statement of the Problem

The rapid increase in sedentary lifestyles is contributing to global health challenges such as obesity, cardiovascular diseases, and diabetes. According to the WHO, over 1.4 billion adults are at risk due to insufficient physical activity, a problem exacerbated by the lack of motivation and guidance in personal fitness journeys ("Physical activity." *World Health Organization (WHO)*, 26 June 2024). While mobile fitness apps have gained popularity, they often fail to engage users long-term or provide personalized solutions.

Locally, in Kenya, the challenge is magnified by the limited availability of tailored fitness tools that cater to the local population's unique needs. Many existing apps are expensive, complex, and inaccessible for most users. The problem lies in the absence of a comprehensive mobile solution that can motivate users, provide real-time workout guidance, and track fitness progress.

The lack of AI-powered personalization, coupled with the absence of interactive AR guidance in most existing apps, leaves users with general workout routines that may not suit their needs. This project seeks to address the gap by developing an intelligent, interactive workout app that can engage users and offer customized fitness experiences.

1.4 Proposed Solution

This research proposes the development of a workout mobile application that incorporates AI to create an engaging, personalized fitness experience. The application will:

- ★ Utilize AI to offer tailored workout plans based on user fitness goals, preferences, and past performance.
- ★ Track workouts and provide users with visual statistics on their progress, encouraging them to stay motivated through daily challenges, streaks, and leaderboards.
- ★ Integrate social sharing features that allow users to post their workout achievements and progress on social media.

The app will not simply digitize manual workout plans; instead, it will bring in modern computational techniques to address the fitness needs of individuals in an innovative and user-friendly way.

A modern example of such an application is the Nike Training Club: Fitness App which is a home workout application that offers a variety of workouts, programs, and guidance to help you reach your fitness goals.
Another modern example is the Strava mobile application which helps runners track their routes and times as they try to improve their runs.These are the two applications I have drawn most of my inspiration and research from to hopefully come up with something with similar successes on a global scale.

1.5 Objectives

General Objective

To develop a mobile application that enhances user fitness experiences by incorporating AI-powered workout personalization, and comprehensive exercise tracking.

Specific Objectives

1. To research and implement AI algorithms that can analyze user data and generate personalized workout plans.
2. To implement features for tracking user progress and presenting statistics through visual graphs and charts.
3. To test and evaluate the app's effectiveness in enhancing user engagement through leaderboards, streaks, and challenges.

1.6 Research Questions

1. How can AI be effectively used to provide personalized workout routines tailored to individual users' needs?
2. How can workout tracking and visual feedback improve user motivation and engagement in their fitness journeys?
3. What are the measurable impacts of incorporating social and leaderboard features on long-term user retention?

1.7 Justification

The development of a fitness mobile application that integrates AI is necessary due to the growing demand for personalized fitness solutions in both global and local contexts. While numerous fitness apps exist, most lack interactive and engaging features that keep users motivated in the long run.

This application will benefit individuals seeking more personalized, interactive fitness experiences and can also contribute to the growing body of research on AI in fitness technology. The app is designed to be scalable, allowing it to serve users not only in Kenya but globally as well.The aspect of competition is highly emphasized in this application which ensures that users stay consistent and can interact with family and friends making the app more interactive and engaging.

1.8 Proposed Research and System Methodologies

The development of the workout application will adopt the **Scrum Development Methodology**. This approach is chosen due to its iterative and incremental nature, which facilitates continuous user feedback, testing, and refinement during each sprint. Scrum will allow the project team to adapt to changing requirements and ensure a user-centered design that aligns with stakeholder expectations.

System Implementation Methodology

The proposed methodology will cover the entire lifecycle of the project, from initial research and planning to deployment and evaluation. Key phases include:

1. **Planning and Requirement Analysis:**
   - Gather requirements through interviews, surveys, and competitor analysis.
   - Prioritize features such as AI-driven workout recommendations, and a leaderboard system.

2. **Design Phase:**
   - Design the system architecture, user interface, and database schema.
   - Use wireframes and mockups to visualize the user experience and layout.

3. **Development Phase:**
   - Divide development tasks into sprints, focusing on individual features (e.g., AI recommendation model, AR integration).
   - Perform daily stand-ups and sprint reviews to ensure progress and address issues.

4. **Testing Phase:**
   - Conduct unit testing, integration testing, and usability testing with a pilot user group.
   - Assess functionality, performance, and user satisfaction for iterative improvements.

5. **Deployment and Maintenance:**
   - Deploy the application on app stores (Google Play and Apple App Store).
   - Gather user feedback post-launch for further optimization.

Tools and Techniques

1. **AI Algorithms:**

- Machine learning models such as **decision trees, collaborative filtering**, and **neural networks** will be implemented to analyze user data, identify patterns, and recommend personalized workout plans.
- Tools such as **TensorFlow** and **scikit-learn** will facilitate the development and training of these models.

2. **Backend Development:**

- The **Django framework** will manage server-side operations, including user authentication, database interactions, and business logic.
- **Django Rest Framework (DRF)** will enable secure and efficient API communication between the Flutter frontend and the backend.
- The database will use **PostgreSQL** to store user data securely and support complex queries efficiently.

3. **Frontend Development:**

- The **Flutter framework** will be used for developing the cross-platform mobile application to ensure consistent performance on both Android and iOS devices.
- Pre-built widgets and plugins from Flutter will accelerate UI/UX development.

4. **Testing and Evaluation:**

- **Unit Testing:** Verify the correctness of individual components like the recommendation model.
- **Integration Testing:** Assess interactions between the Flutter frontend and Django backend.
- **Usability Testing:** Conduct with a small user group to gather feedback on the app's interface and overall experience.

Justification for the Chosen Methodology

The Scrum methodology is ideal for this project due to its focus on:

★ **Flexibility:** It accommodates the iterative refinement of features like AI recommendations.

- ★ **User-Centric Design:** Regular sprints and reviews ensure the app aligns with user expectations and needs.
- ★ **Efficiency:** Tasks are broken into manageable sprints, enabling focused development and quicker identification of issues.

Lifecycle Coverage

This methodology ensures the project lifecycle is covered comprehensively:

- ★ **Research and Analysis:** Understand user needs and competitive benchmarks.
- ★ **Development:** Build a robust and scalable application architecture.
- ★ **Testing:** Ensure the app is functional, secure, and user-friendly.
- ★ **Deployment:** Deliver the app to end users, followed by ongoing updates and support.

1.9 Scope

The scope of this project will be confined to the development and evaluation of a mobile workout application designed to promote fitness and health among users. The application will focus on these core areas:

1. **Workout Personalization:** Leveraging AI to analyze user fitness levels and preferences to generate tailored workout plans.
2. **Exercise Tracking:** Implementing features to monitor and analyze users' physical activities, progress, and adherence to workout regimens.

Geographical and Target Focus

The primary focus group for this project will be individuals in Kenya who seek an accessible, affordable, and comprehensive fitness solution via their mobile devices. While the initial design and implementation aim to address local needs, the system architecture will ensure scalability for a global audience. This includes considerations for diverse fitness requirements and cultural contexts.

Potential Limitations

The following constraints may impact the project:

1. **Fitness Data Availability:**

- The quality and diversity of datasets required to train AI models may be limited, affecting the accuracy and relevance of workout recommendations.
- Efforts will be made to source data from publicly available fitness datasets and user-provided inputs during the pilot phase.

2. **Device Requirements:**

- Compatibility will be optimized for mid-range and high-end smartphones to include as many users as possible.

3. **Resource Constraints:**

- Limited financial and technical resources may restrict advanced features like 3D modeling for AR or extensive backend scalability during the development phase.
- Collaborations and use of open-source tools will mitigate some of these constraints.

Project Boundaries

The project is confined to software development for mobile platforms and does not include:

- The design or manufacture of fitness equipment or wearables.
- Direct integration with hardware beyond basic APIs such as **Google Fit** or **Apple Health**, which provide standard fitness tracking data.
- Medical-grade fitness recommendations or diagnostics, as the application is designed solely for general fitness purposes and not for healthcare or medical use.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The rapid advancement of technology has significantly influenced the fitness industry, introducing innovative solutions that enhance workout experiences, foster motivation, and improve health outcomes. This chapter explores the theoretical underpinnings, practical implementations, and existing research gaps related to AI-powered fitness applications, with a particular focus on the integration of Artificial Intelligence (AI). These technologies have become increasingly relevant in the modern fitness landscape due to their ability to offer personalized, interactive, and data-driven workout solutions.

Background and Relevance

Globally, fitness applications are becoming a critical component of health and wellness routines, driven by advancements in AI technologies. AI systems in fitness, such as those embedded in wearable devices like Fitbit and Apple Watch, analyze user activity, track health metrics, and provide real-time recommendations tailored to individual goals. Similarly, AR-based platforms such as Zwift and Supernatural offer immersive workout environments, merging physical and virtual activities to enhance user engagement. ("AI in Fitness Apps: Why It's a Game Changer." Consagoustech on Medium, 5 September 2023)

The adoption of fitness technologies has not only transformed individual workouts but also revolutionized how fitness content is delivered and consumed. For example, AIpowered recommendations have enabled users to receive custom workout plans, reducing the reliance on traditional gym instructors. Concurrently, AR applications create engaging virtual environments, enabling users to interact with avatars or participate in simulated training scenarios from the comfort of their homes.

Local Context

In Kenya and other developing regions, fitness applications are gaining traction as alternatives to traditional gyms. With urbanization and the growing awareness of fitness and health, there is a rising demand for affordable, flexible, and technology-driven fitness solutions. Despite this growth, several challenges persist:

1. Limited personalization in existing fitness applications, which often fail to accommodate the diverse fitness goals of users.
2. Lack of consistent user motivation, resulting in underutilization of fitness apps.
3. Minimal adoption of advanced technologies like AR and AI, primarily due to resource constraints and the nascent stage of the market.

Purpose and Objectives

This literature review seeks to:

1. Examine the theoretical frameworks underpinning the use of AI and AR in fitness applications, including their advantages and limitations.
2. Analyze real-world implementations of AI and AR technologies within fitness contexts, highlighting successful use cases and lessons learned.
3. Identify the existing research and technological gaps in AI and AR-powered fitness applications, focusing on their relevance to the Kenyan context.
4. Provide a foundation for the development of a workout application that effectively integrates AI and AR to offer personalized workout experiences, realtime guidance, and comprehensive fitness tracking.

2.2 Theoretical Review

Key Concepts in AI-Powered Fitness Applications

1. **Personalized Recommendations**:
AI recommendation systems analyze user data such as preferences, fitness goals, and activity history to suggest relevant workouts. These systems employ techniques like collaborative filtering (grouping users with similar preferences) and content-based filtering (suggesting workouts based on user history).
2. **Exercise Tracking**:
Leveraging AI-powered sensors and computer vision, exercise tracking ensures that users perform workouts correctly. Models like OpenPose or MediaPipe detect and evaluate body posture, providing corrective feedback in real time.
3. **Gamification**:
By incorporating elements such as points, badges, and leaderboards, fitness applications motivate users to achieve fitness goals while fostering a sense of competition and community.
4. **Data Collection and Analysis**:
Fitness applications gather structured data (e.g., age, weight, workout history) and unstructured data (e.g., video feeds) to train AI models. Analyzing this data provides actionable insights to users.

Theoretical Divisions

1. AI-Driven Personalization:

Advantages of AI-Driven Personalization:

- **Dynamic Adaptation:** AI algorithms continuously learn from user interactions, creating increasingly precise workout plans that evolve with the user's fitness journey. This means the recommendations become more accurate over time, addressing individual progress, limitations, and goals.
- **Psychological Motivation:** Personalized plans create a sense of individual attention, increasing user engagement and adherence. When users feel the workout is specifically tailored to them, they're more likely to stay committed.

- **Injury Prevention:** By analyzing user data, AI can suggest modifications or alternative exercises that suit individual physical capabilities, reducing the risk of overexertion or improper training.
- **Comprehensive Analysis:** AI can integrate multiple data points including age, fitness level, previous injuries, body composition, and performance metrics to create holistic workout recommendations.

Limitations:

- **Data Quality Dependency:** The effectiveness of personalization is directly tied to the quality and quantity of available user data. Sparse or incomplete data can lead to generic or inaccurate recommendations.
- **Privacy Concerns:** Collecting and analyzing extensive personal data raises significant privacy and data protection challenges.
- Computational Complexity: Developing sophisticated personalization algorithms requires substantial computational resources and advanced machine learning expertise.
- **Potential Bias:** If training data is not diverse, AI models might perpetuate existing biases or provide less effective recommendations for underrepresented user groups.
- **Initial Cold Start Problem:** New users with limited historical data pose challenges for recommendation systems, as there's insufficient information to generate truly personalized plans.

2. Augmented Reality (AR) in Fitness:

Advantages:

- **Enhanced Engagement:** AR transforms traditional workouts into interactive, immersive experiences. Users can visualize exercises, track progress, and interact with virtual elements, making fitness more enjoyable.
- **Real-Time Feedback:** AR can overlay form correction guidance, providing immediate visual cues about exercise technique, alignment, and performance.
- **Accessibility:** Virtual trainers and guided workouts can make professional fitness instruction available to users who cannot afford in-person training.

- **Gamification Potential:** AR enables the creation of interactive challenges, virtual environments, and competitive scenarios that motivate users to exercise.
- **Spatial Learning:** Users can better understand complex movements through 3D visualizations and interactive demonstrations.

Limitations:

- Hardware Dependency: High-quality AR experiences require advanced smartphones or specialized equipment, creating a technological and financial barrier.
- Technical Complexity: Developing seamless AR experiences demands significant technical expertise in 3D modeling, computer vision, and user interface design.
- Performance Variability: AR performance can be inconsistent due to differences in device capabilities, lighting conditions, and user environments.
- User Adaptation: Not all users are comfortable with or skilled in using AR technologies, which can create a learning curve.
- Battery and Performance Drain: AR applications can be computationally intensive, potentially reducing device battery life and performance.

2.3 Case Study Review: Digital Fitness Platforms Analysis

1. Strava: Social Fitness Tracking and Community Engagement Platform

Applications

Strava is a versatile fitness application that primarily focuses on activity tracking, social networking, performance analytics, and training planning. It leverages GPS-based tracking to monitor activities such as running, swimming, and cycling, providing users with detailed statistics like distance, pace, and elevation. The platform also functions as a social network for athletes, fostering global connectivity and engagement. Additionally, Strava includes tools for route planning and segment tracking, catering to athletes' needs for tailored training sessions.

Key Implementations

Strava excels as a social fitness tracker with features like GPS-enabled activity recording, automatic synchronization from multiple devices, and competitive leaderboards for segments. It rewards users with virtual achievement badges and organizes virtual competitions to motivate them. Its technical architecture employs machine learning algorithms to analyze fitness trends, predict performance, and provide personalized route recommendations. Real-time social interaction features and cloudbased data storage enhance user experience and data reliability.

Successes

Strava has successfully cultivated a global community of over 100 million users, offering advanced performance metrics such as pace analysis, elevation tracking, and comparative insights. Its motivational features, including virtual challenges and community engagement, have set a benchmark for fitness applications. Moreover, the app's support for diverse activities makes it a comprehensive tool for multi-sport athletes.

Potential Limitations

Despite its strengths, Strava has some notable limitations. Users may face privacy concerns due to detailed location tracking, and the app relies heavily on GPS and internet connectivity, limiting offline functionality. Subscription-based restrictions can also hinder access to advanced features. Additionally, the emphasis on performance comparisons might create anxiety among some users.

2. Nike Run Club: Intelligent Running Companion

Applications

Nike Run Club (NRC) is a fitness app designed specifically for runners, offering personalized guidance, adaptive training plans, and audio-guided running experiences. The app also tracks and analyzes performance, delivering insights into pace, distance, and overall progress. Its motivational support system includes features like guided runs from professional athletes and contextual audio feedback to keep users engaged.

Key Implementations

NRC employs AI-powered training recommendations, tailoring workout plans based on individual fitness levels, past performance, and specific goals. Machine learning

algorithms enable personalized coaching, ensuring each user receives an adaptive and progressive training experience. Motivational audio features include real-time feedback, professional athlete guidance, and coaching that adjusts to users' performance. These elements create an immersive and supportive running environment.

Successes

Nike Run Club provides a holistic running experience that combines advanced technology with motivational support. Its personalized training plans and progressive difficulty scaling cater to runners of all skill levels, while audio coaching helps reduce monotony during workouts. By offering professional athlete interactions and free basic features, NRC remains accessible to beginners and experienced runners alike.

Potential Limitations

While NRC is an excellent tool for runners, it has its drawbacks. The app's narrow focus on running limits its usability for those interested in other fitness activities. Crossplatform integration is restricted, and audio guidance may not appeal to all users. Additionally, advanced athletes might find some recommendations overly generic, and there is a potential risk of over-reliance on technology for training success.

2.4 Integration and Architecture

AI Integration

AI can be incorporated in several ways to enhance user experience:

- ★ **Recommendation Models**: Machine learning algorithms such as collaborative filtering, neural networks, and matrix factorization will power workout recommendations. Libraries like TensorFlow or PyTorch can be used to train these models.
- ★ **Computer Vision**: For real-time form analysis, pre-trained models like OpenPose can detect body joints and angles. This ensures exercises are performed correctly.
- ★ **Natural Language Processing (NLP)**: Implement virtual assistants to guide users through workouts or answer fitness-related queries.

Proposed Architecture

1. **Frontend**: Flutter framework for cross-platform mobile application development.
2. **Backend**: Django REST Framework for API development and database management.
3. **Database**:
    - PostgreSQL for structured user and workout data.
    - MongoDB for unstructured data like video uploads.
4. **AI Hosting**: Cloud-based platforms like AWS SageMaker or Google AI for model training and deployment.

2.5 Summary

The literature review highlights the widespread application of AI and AR in fitness, underscoring their potential to revolutionize the workout experience. While existing applications successfully employ AI for personalization and AR for interactivity, challenges such as data sparsity, hardware dependency, and high costs limit broader adoption. This project aims to address these gaps by leveraging hybrid recommendation systems, seamless AR integration, and advanced analytics.

2.6 Research Gaps

1. **Limited AR-AI Integration**: Few applications combine AR and AI effectively to deliver real-time feedback and immersive experiences.
2. **Personalization Challenges**: Most recommendation systems fail to adapt dynamically to changes in user performance or preferences.
3. **Gamification Elements**: Current implementations underutilize gamification features for user retention.
4. **Lack of Analytical Insights**: Fitness applications often lack robust analytics, limiting their ability to guide users on improving long-term performance.

Proposed Resolutions

- ★ Integrate AI to enable real-time, immersive feedback.
- ★ Design hybrid recommendation systems that combine real-time data and user history.
- ★ Incorporate engaging gamification features like leaderboards and achievements.
- ★ Develop visual analytics tools to provide actionable insights for users.

References

Strain, T., Flaxman, S., et al. National, regional, and global trends in insufficient physical activity among adults from 2000 to 2022: a pooled analysis of 507 populationbased surveys with 5·7 million participants. The Lancet Global Health (2024).

Guthold, R., Stevens, G., et al. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1.6 million participants. The Lancet Child & Adolescent Health Vol. 4 Iss. 1 (2019).

APPENDICES

Project Resources

The development of the workout mobile application will require a combination of human, technical, and financial resources:

Human Resources

- ★ **Project Manager:** Responsible for overseeing the development process, coordinating between teams, and ensuring milestones are met.
- ★ **Software Developers:** Flutter developers for the frontend and Django developers for the backend.
- ★ **UI/UX Designer:** Ensures the application is intuitive, visually appealing, and user-friendly.
- ★ **AI Specialist:** Develops machine learning models for personalized workout recommendations.

- ★ **Quality Assurance Team:** Tests the application for functionality, usability, and security.
- ★ **Fitness Consultant:** Provides expertise in workout routines and fitness-related content.

Technical Resources

- ★ **Development Tools:** Flutter SDK, Django framework, ARCore, ARKit, and Firebase for authentication.
- ★ **Hardware:** High-performance computers and AR-capable mobile devices for testing.
- ★ **Software:** Integrated Development Environments (IDEs) such as Android Studio and PyCharm, cloud-based collaboration tools, and Git for version control.
- ★ **Infrastructure:** Hosting services for backend deployment and cloud storage for data.

Other Resources

- ★ **Data:** Access to fitness datasets for training AI models.
- ★ **Office Space:** Collaboration and testing environments for the development team.

Budget

Category	Estimated Cost
Human Resources	
Self Development	-
Technical Resources	
Hardware and Mobile Phone	-
Software and Licenses	-
Hosting and Cloud Services	100,000
Miscellaneous	
Marketing and Outreach	50,000
Total Estimated Budget	150,000

Table 1: Project Budget

Project Schedule

Below is a gantt chart outlining the timelines of the project.

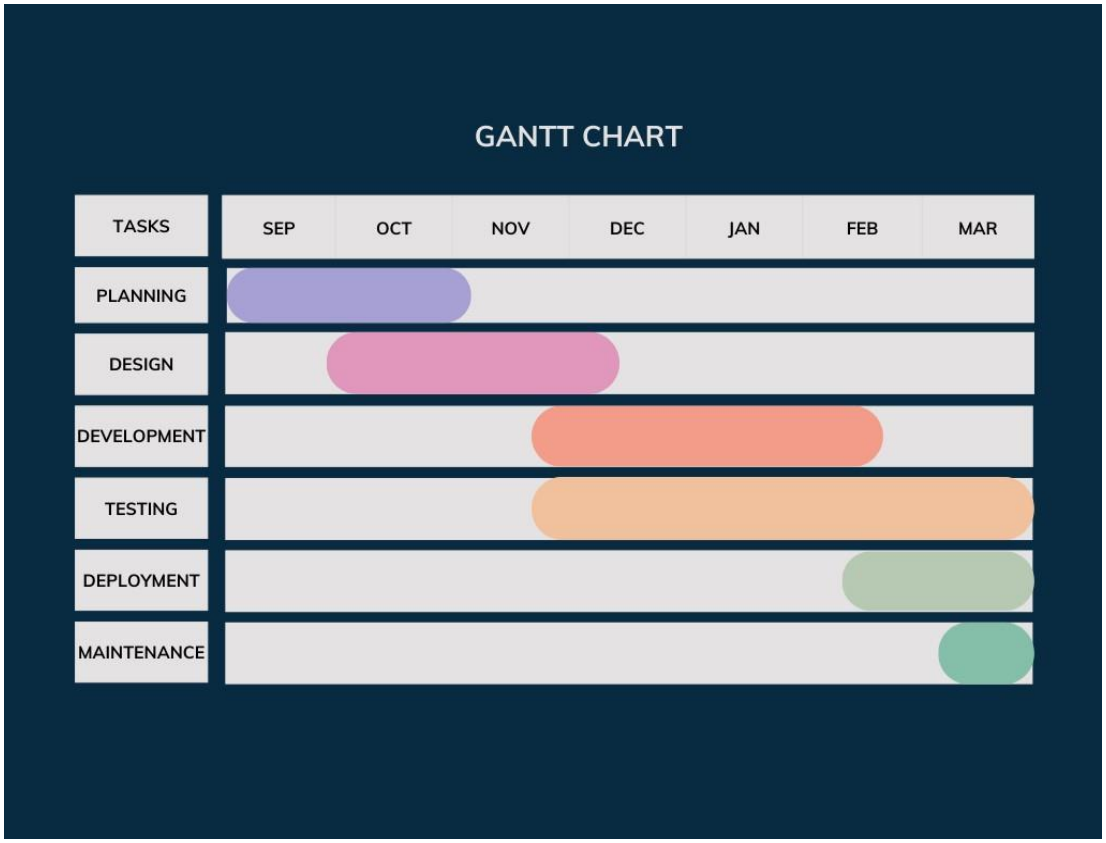

Figure 2: Gaant Chart

Milestones

- ★ **End of December:** Complete project planning and design.
- ★ **End of February:** Functional prototype with basic AI features.
- ★ **End of March:** Fully tested application ready for deployment.
- ★ **End of April:** App deployed on app stores with post-launch support in place.

CHAPTER 3: SYSTEM ANALYSIS AND DESIGN

3.1 Introduction

This chapter details the analysis and design process for the workout mobile application. It outlines the chosen systems development methodology, project feasibility, requirements elicitation, data analysis, system requirements, logical design, and physical design. The chapter provides an in-depth understanding of how the system is designed to meet user needs, ensuring a well-structured approach to development.

3.2 Systems Development Methodology

The Scrum Development Methodology is used for the development of the workout mobile application. Scrum, an agile methodology, facilitates iterative and incremental development, enabling continuous feedback from stakeholders and users. This methodology ensures adaptability to changing requirements, high-quality deliverables, and user-focused features, making it ideal for this AI-powered workout application.

3.3 Feasibility Study

3.3.1 Economic Feasibility

The workout application is economically feasible as it is built using open-source tools like Django (backend) and Flutter (frontend). The initial cost involves development, deployment, and testing, which are minimized due to freely available resources. Longterm revenue models can include premium subscriptions and ads to ensure financial sustainability.

3.3.2 Technical Feasibility

The project is technically feasible with the use of existing technologies:

- Backend: Django and Django Rest Framework (DRF) for API development.
- Frontend: Flutter framework for cross-platform mobile app development.
- AI Integration: Neural networks and decision trees for workout personalization.
- These tools are compatible with the intended project requirements and can be integrated smoothly.

3.3.3 Operational Feasibility

The application is easy to use, intuitive, and designed to meet the needs of fitness enthusiasts of all levels. Deployment on mobile devices ensures accessibility for the target audience. A small user-testing group will validate operational success before public launch.

3.3.4 Legal and Ethical Feasibility

The application adheres to data privacy regulations, such as GDPR, by implementing robust security measures. User consent will be sought for data collection and AI usage.

Feasibility Type	Summary
Economic	Uses open-source tools (Django, Flutter), low-cost development, revenue model via ads/subscriptions.
Technical	Uses existing AI technologies, compatible with mobile devices.
Operational	User-friendly, supports fitness enthusiasts at all levels.
Legal/Ethical	Complies with GDPR, ensures user data security.

Table 2: Feasibility Study Summary

3.4 Requirements Elicitation

3.4.1 Data Collection Tools

Questionnaires were selected as the primary data collection tool, as they are efficient in reaching a wide audience. They include structured questions about fitness habits, technology familiarity, user expectations, and preferences for AR-based guidance.

3.4.2 Sampling Techniques

A stratified random sampling technique was used to ensure diverse user input. A sample size of 50 respondents was selected, consisting of fitness enthusiasts, beginners, and tech-savvy individuals.

3.4.3 Relevance to Objectives

The collected data focuses on user needs, workout habits, and preferred features, aligning with the research objectives. It informs functional requirements for AI-based workout personalization.

3.5 Data Analysis

The data collected through questionnaires was analyzed using Microsoft Excel. Key insights are presented visually:

User Preferences for AR Integration:
% of users expressed interest in real-time AR workout guidance.

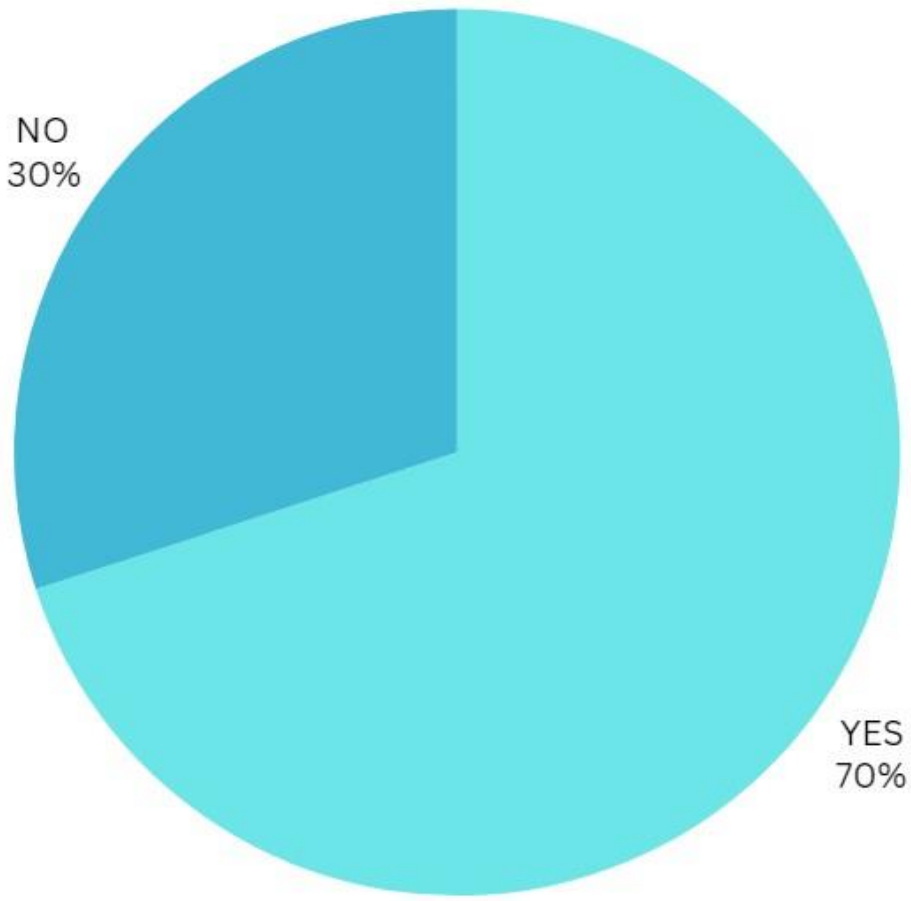

Figure 3: % of users expressed interest in real-time AR workout guidance.

Workout Personalization Demand:
% of respondents prioritized personalized workout plans.

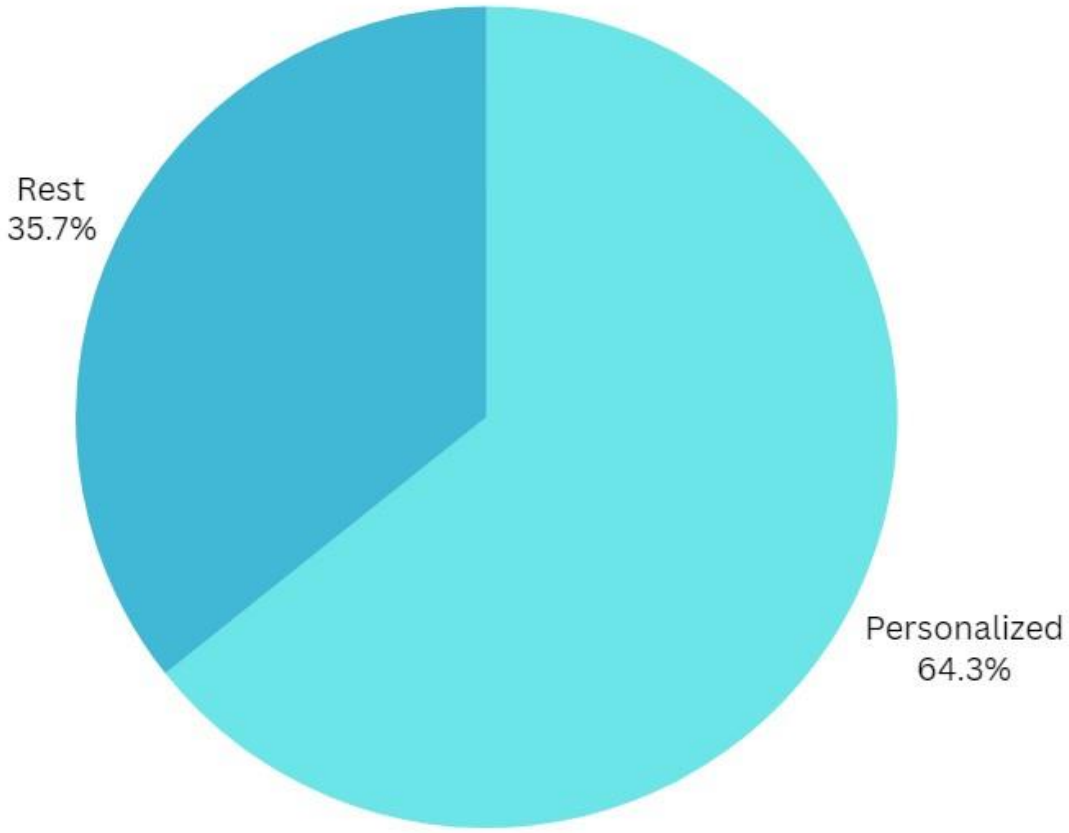

Figure 4: % of respondents prioritized personalized workout plans.

Device Accessibility:

% of users have devices compatible with ARCore/ARKit.

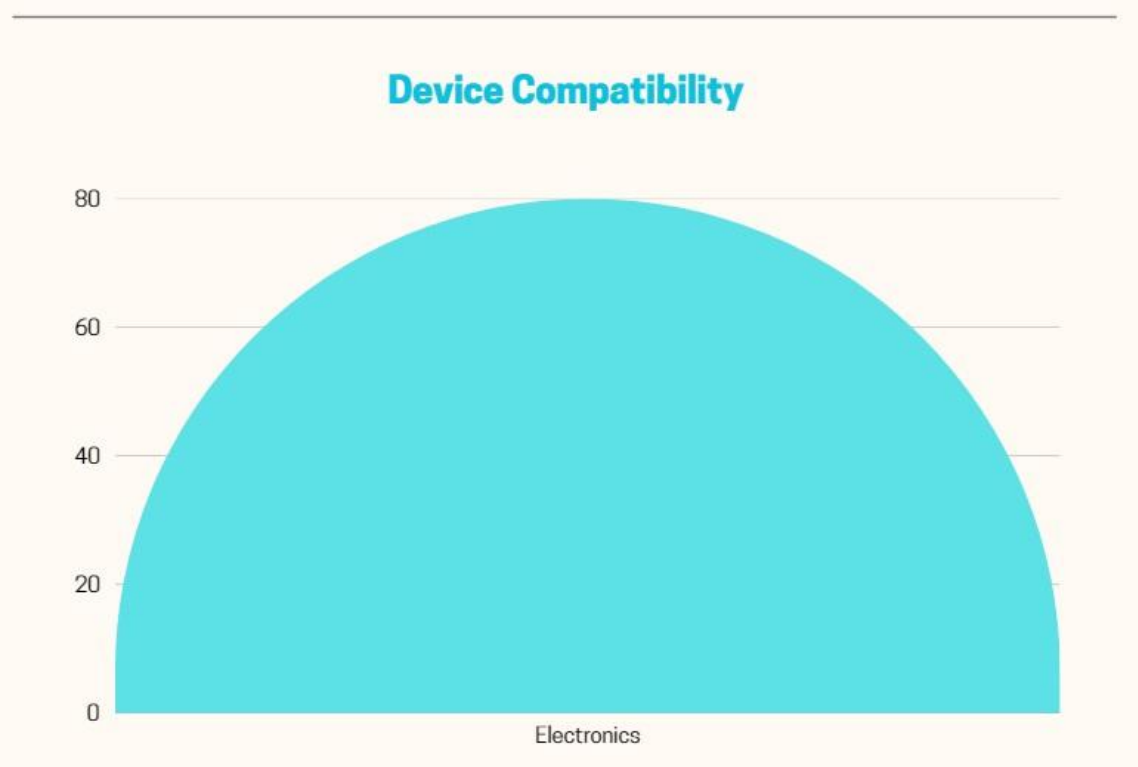

Figure 5: % of users have devices compatible with ARCore/ARKit.

The analysis highlights user preferences and technology readiness, shaping system requirements.

3.6 System Specification

3.6.1 Functional Requirements

- Users can register and log in securely.
- The system recommends personalized workout plans using AI.
- Users can track workout history and progress.
- Integration with APIs such as Google Fit and Apple Health.

3.6.2 Non-Functional Requirements

- Performance: The app should respond within 3 seconds for most tasks.
- Usability: Intuitive and user-friendly interface.
- Security: User data encryption and secure authentication.
- Scalability: Support for an increasing user base.
- Availability: 99% uptime for seamless access.

Requirement	Description
User Authentication	Users can register and log in securely
Workout Recommendations	AI recommends personalized workouts.

Table 3: Summary of System Functional Requirements

Requirement	Description
Performance	App responds within 3 seconds.
Security	Uses JWT authentication and enctryption

Table 4: Summary of System Non-Functional Requirements

3.7 Requirements Analysis and Modeling

The requirements gathered were analyzed for dependencies and structured into system components. Tools used for modeling include:

Use Case Diagram:

Represents core user interactions like login, and progress tracking

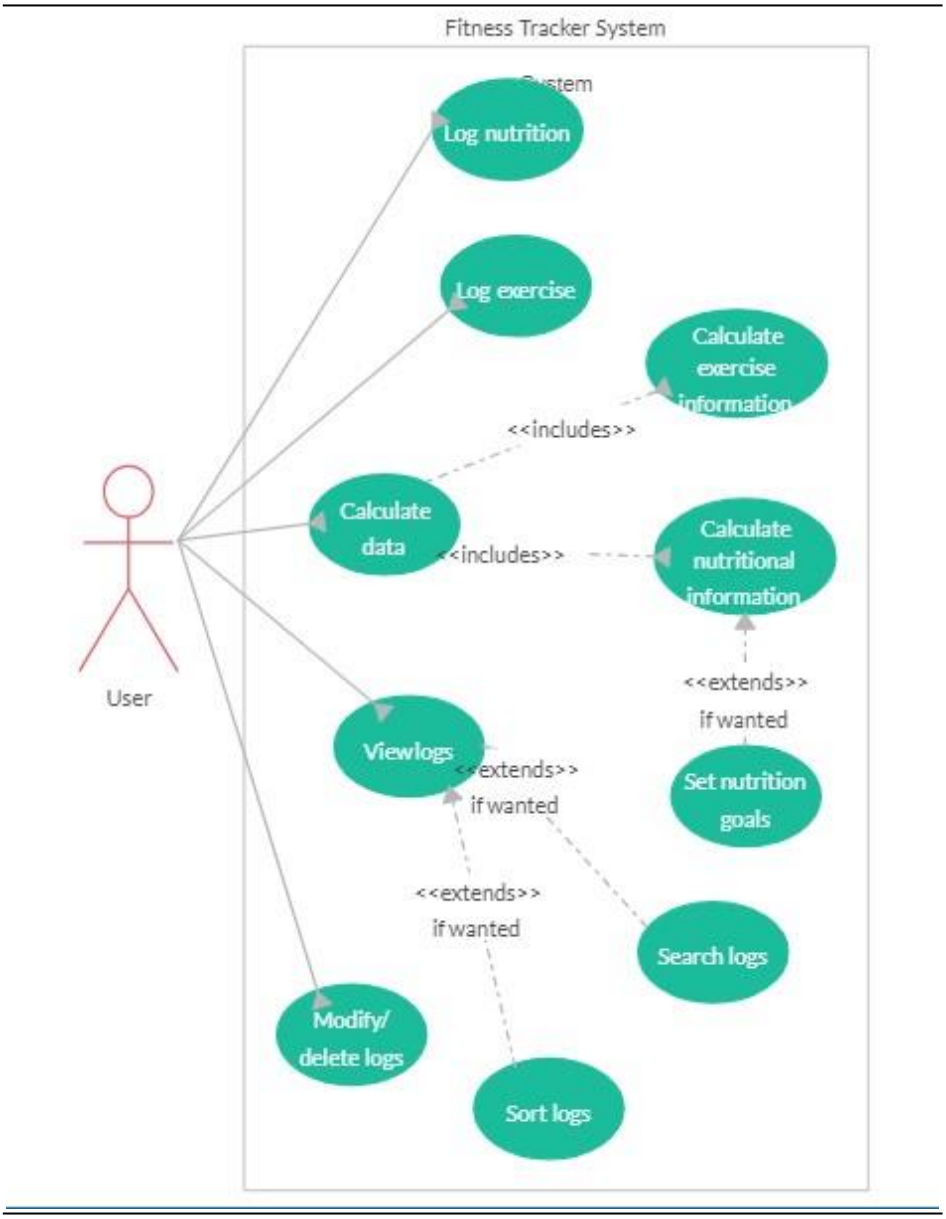

Figure 6: Use Case Diagram representing core user interactions

Data Flow Diagram (DFD):

Illustrates data flow between components such as the user and the backend server.

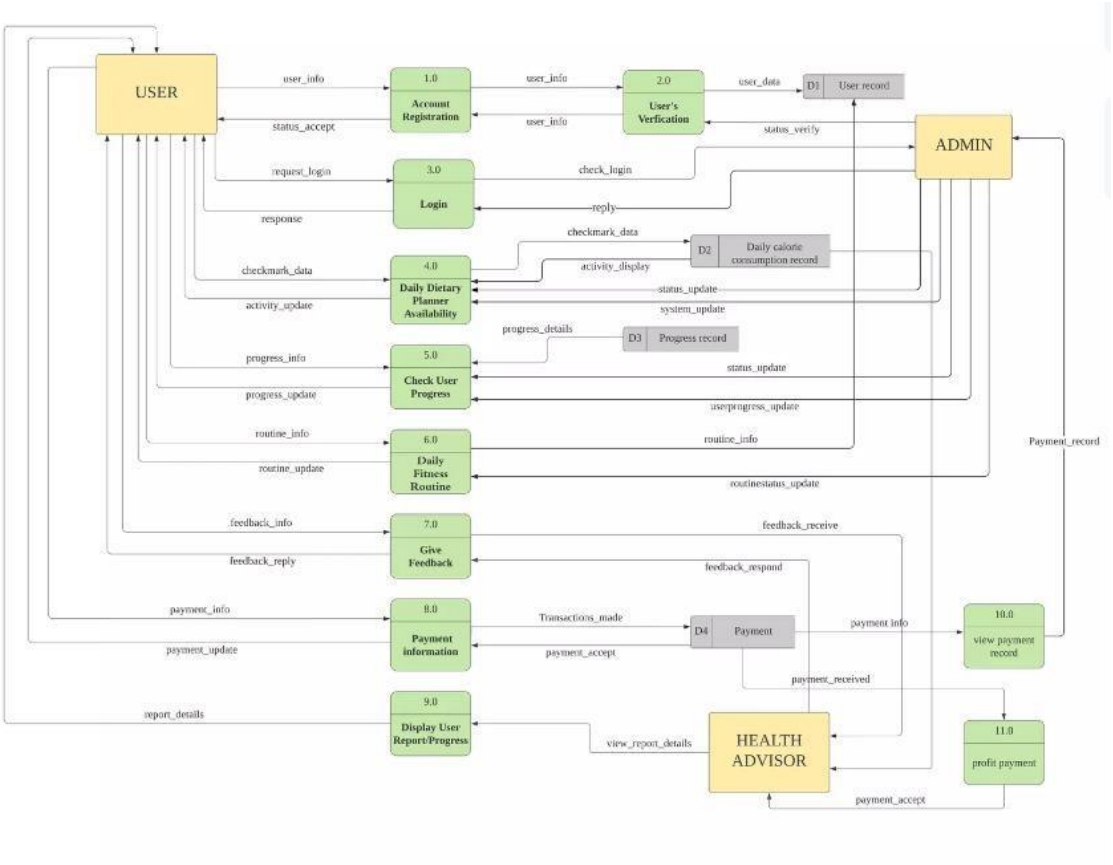

Figure 7: Data flow between components

Class Diagram:

Captures the relationship between system classes, such as User, WorkoutPlan, and ProgressTracker.

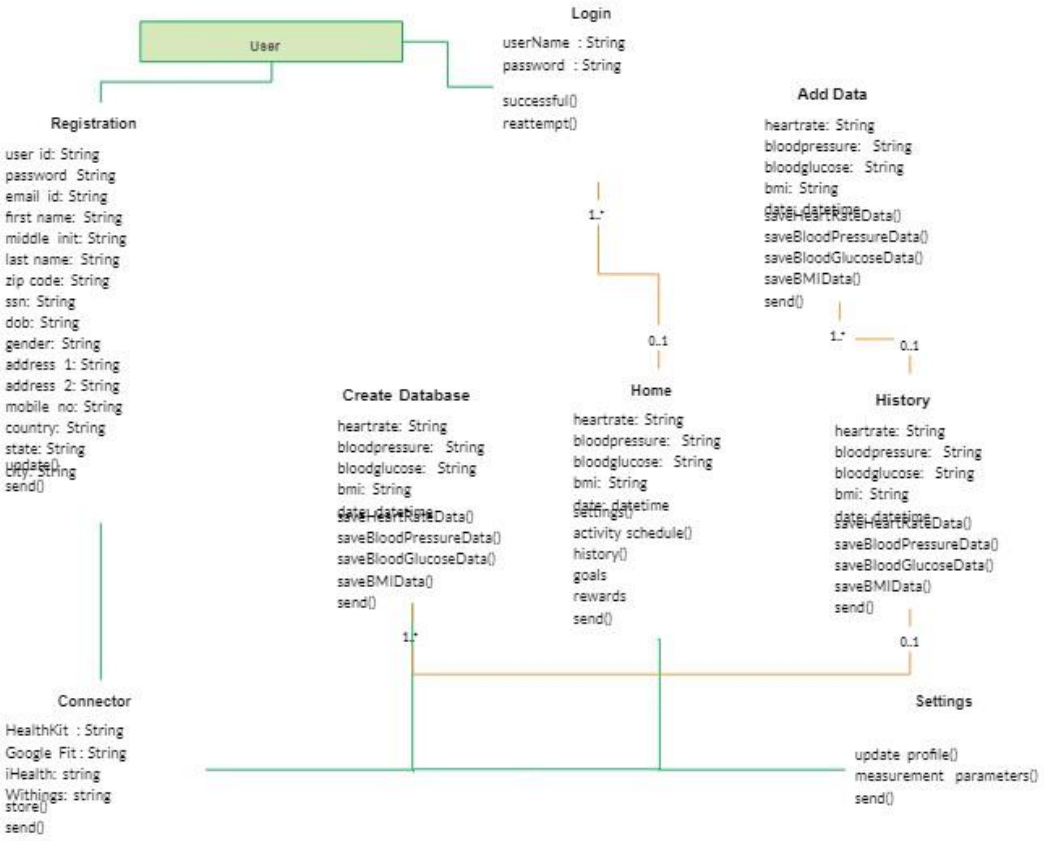

Figure 8: relationship between system classes

3.8 Logical Design

3.8.1 System Architecture

The application follows a client-server architecture:

Frontend: Built using Flutter for mobile devices.
Backend: Django handles server-side operations and API development.
AI Layer: Neural networks and decision trees for recommendations.

Figure 9: A visual representation of the client-server structure

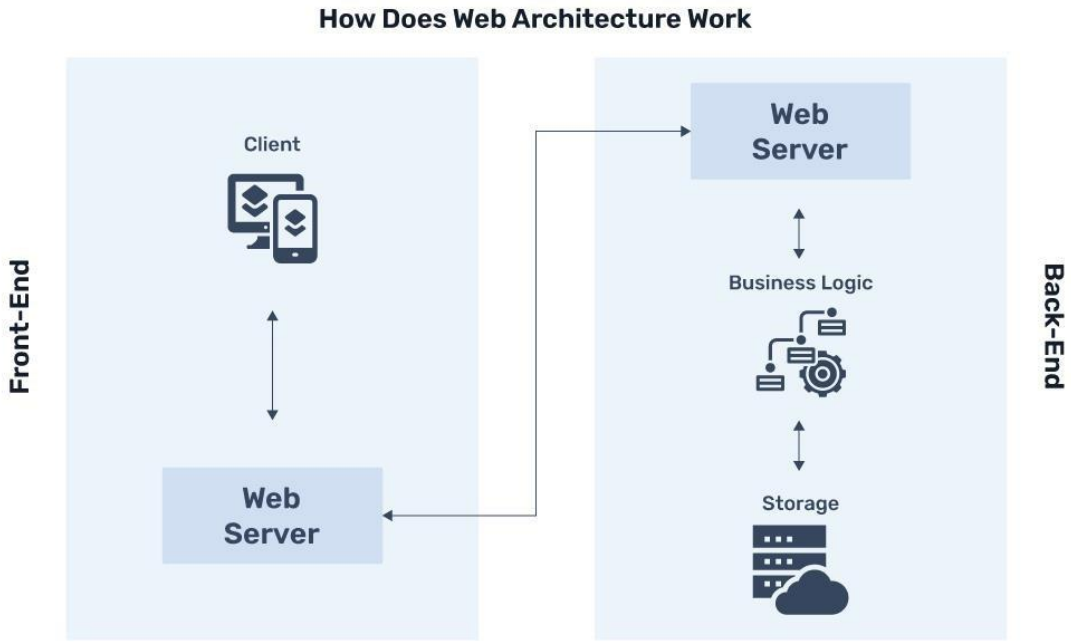

Figure 10: A visual representation of the client-server structure

3.8.2 Control Flow and Process Design

Flowcharts describe the sequence of processes, such as user login and the AI-based workout recommendation. Sequence diagrams show the interaction between the user and the backend.

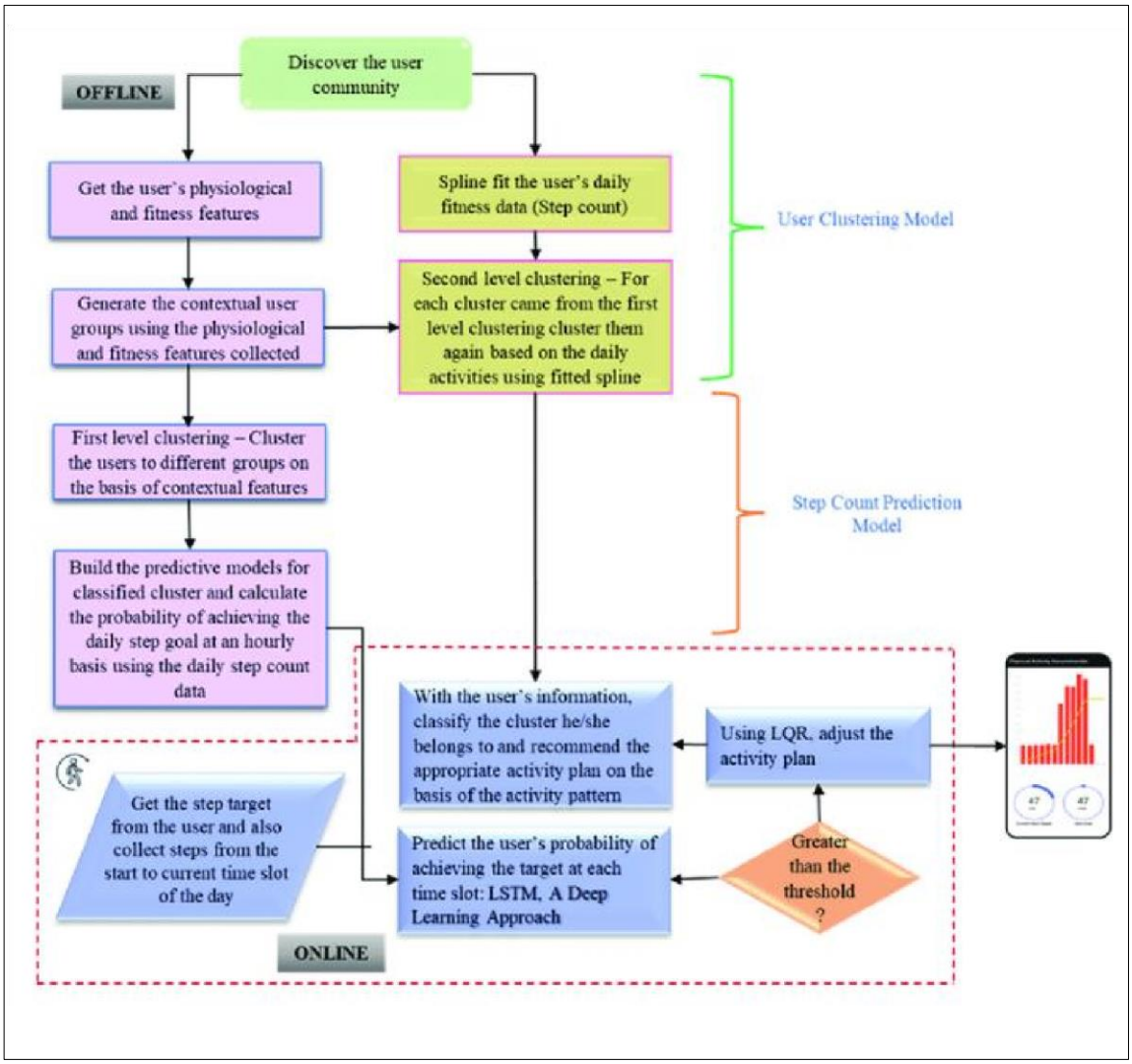

Figure 11: Control Flow and Process Design

3.8.3 Design for Non-Functional Requirements

Security: JWT-based secure authentication and encryption of user data.

Error Handling: Structured exception handling ensures smooth user experiences.

Efficiency: Optimized API endpoints to minimize response time.

3.9 Physical Design

3.9.1 Database Design

The database uses SQLite for initial development. Tables include:

- Users Table: User ID, name, email, password, and fitness level.
- Workout Table: Workout ID, plan type, duration, and difficulty.
- Progress Table: Records user activities, calories burned, and progress updates.
- A relational schema ensures data integrity and efficient queries.

Table Name	Fields
Users	user_id, name, email, password, fitness_level
Workouts	workout_id, plan_type, duration, difficulty
Progress	progress_id, user_id, calories_burned, date

Table 5: Table showing key database tables and their fields

3.9.2 User Interface Design

The UI prioritizes simplicity and usability, with the following wireframes designed using Figma:

1. Login Screen: User authentication page.
2. Dashboard: Displays personalized workout plans.

3. Workout Screen: Video guided workout display.

4. Progress Screen: Visual representation of workout history and achievements.

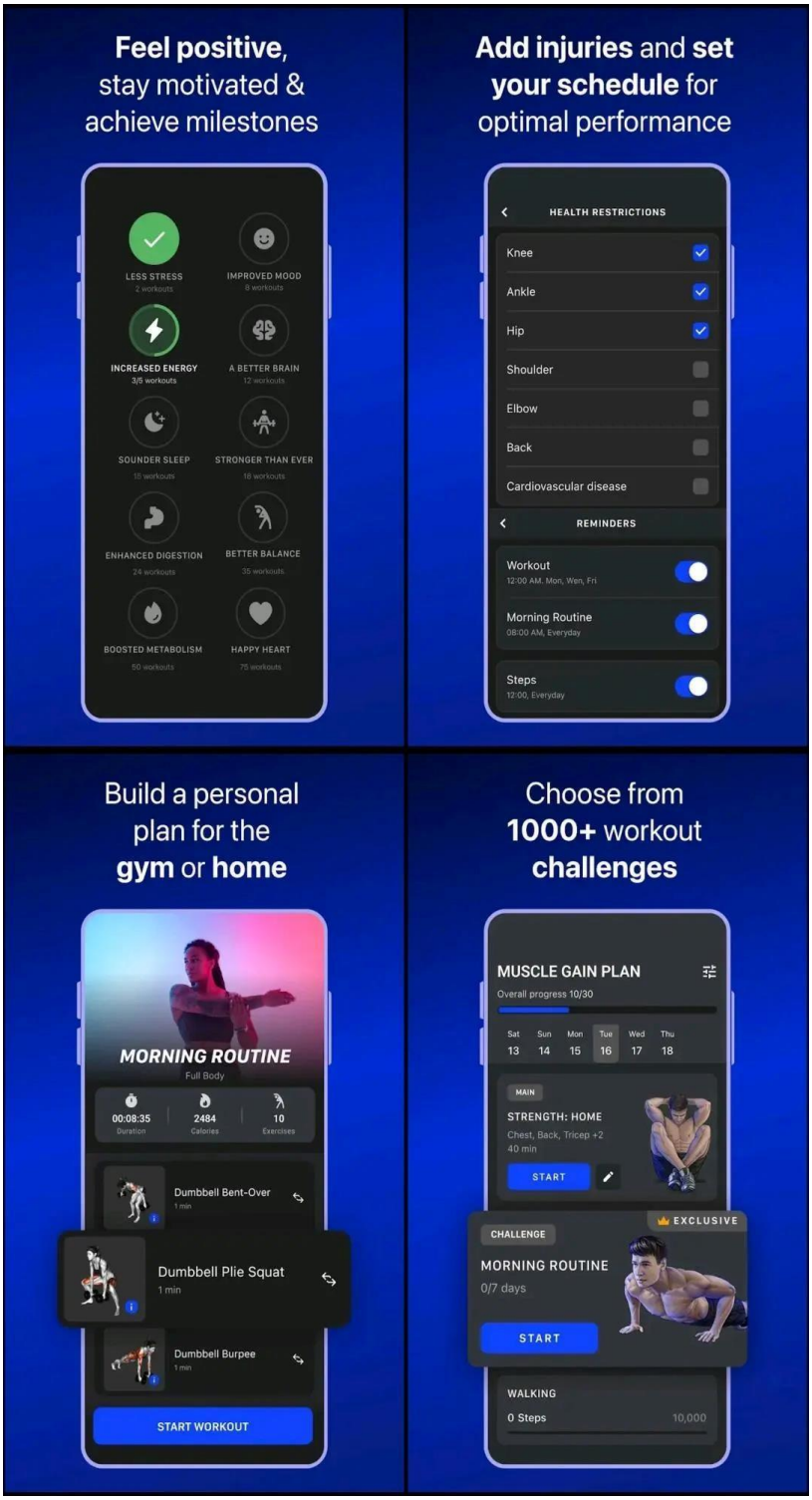

Figure 12: Screenshots for various pages

Conclusion

This chapter details the system analysis and design process, from feasibility study to logical and physical design. The methodologies, specifications, and design components ensure a robust foundation for developing the workout application.

CHAPTER 4: SYSTEM IMPLEMENTATION AND TESTING, CONCLUSIONS AND RECOMMENDATIONS

4.1 Introduction

This chapter covers the system implementation, testing, conclusions, and recommendations. It details the tools and environment used for the development, the process of generating the system code, testing methodologies, and user guidelines. Finally, it discusses the project's success, challenges encountered, and recommendations for future improvements.

4.2 Environment and Tools

The implementation environment includes tools and technologies used for the development of the workout application, covering backend, frontend, and additional services.

4.2.1 Backend Development

Component	Description
Programming Language	Python
Framework	Django and Django Rest Framework (DRF) for API creation.
Database	SQLite for development, scalable to PostgreSQL in production.
Libraries	TensorFlow and Scikit-learn for AI (Neural Networks and Decision Trees).

Table 6: Backend development tools

4.2.2 Frontend Development

Component	Description
Framework	Flutter for cross-platform mobile application development (Android and iOS).
Languages	Dart

UI Design Tool	Figma for wireframing and interface design.

4.2.3 Other Tools

Table 8: Other tools

Component	Description
Version Control	Git and GitHub for code management.
IDE	PyCharm (backend) and Visual Studio Code (frontend).
Testing Tools	Postman for API testing, Flutter's testing framework, and manual user testing.

Table 7: Frontend Development Tools

4.3 System Code Generation

The system was developed iteratively using the Scrum methodology. Below is an explanation of key processes and their implementation, including code snippets.

4.3.1 User Registration and Authentication (Backend)

The authentication system uses Django's JWT-based token for secure user management.

```python
# views.py - User registration
from rest_framework.decorators import api_view
from rest_framework.response import Response
from .models import User
from .serializers import UserSerializer
from rest_framework_simplejwt.tokens import RefreshToken

@api_view(['POST'])
def register_user(request):
    serializer = UserSerializer(data=request.data)
    if serializer.is_valid():
        user = serializer.save()
        token = RefreshToken.for_user(user)
        return Response({
            'message': 'Registration Successful',
            'access_token': str(token.access_token)
        })
    return Response(serializer.errors, status=400)
```

Figure 13: Code snippet for User Registration and Authentication

4.3.2Personalized Workout Recommendations (AI Implementation)

AI models (Neural Networks and Decision Trees) analyze user inputs to recommend workouts.

```python
# AI-based recommendation snippet
import numpy as np
from sklearn.tree import DecisionTreeClassifier

# Sample workout dataset
data = np.array([[20, 1], [30, 2], [40, 2], [50, 3]])  # [age, fitness level]
labels = ['light', 'moderate', 'moderate', 'intense']

# Decision Tree Model
model = DecisionTreeClassifier()
model.fit(data, labels)

# Predicting workout level
user_input = np.array([[35, 2]])
print(model.predict(user_input))  # Output: moderate
```

Figure 14: AI Implementation

4.3.3 Frontend Code for AR Integration

AR implementation triggers using Flutter's ARCore package.

```dart
import 'package:arcore_flutter_plugin/arcore_flutter_plugin.dart';

class ARWorkoutScreen extends StatelessWidget {
  @override
  Widget build(BuildContext context) {
    return Scaffold(
      appBar: AppBar(title: Text("AR Workout")),
      body: ArCoreView(
        onArCoreViewCreated: _onArCoreViewCreated,
      ),
    );
  }

  void _onArCoreViewCreated(ArCoreController controller) {
    controller.addArCoreNode(ArCoreReferenceNode(
      name: "WorkoutGuide",
      objectUrl: "path-to-ar-model.glb",
    ));
  }
}
```

Figure 15: Code for AR Integration

4.4 Testing

4.4.1 Testing Strategies

Testing Type	Description
Unit Testing	Ensures each function works independently.
Integration Testing	Verifies data flow between frontend and backend.
User Acceptance Testing (UAT)	Real users validated app usability and functionality

Table 8: Testing Strategies

4.4.2 Test Cases and Results

Test	Description
User Registration Test	Validates successful user registration
Workout Recommendation Test	AI predicts the best workout based on user input.

Table 9: Test Cases and Results

4.5 User Guide

4.5.1 Setting Up the Application

1. Download and install the app from Google Play Store or Apple App Store.
2. Launch the app and create an account using your email and password.

4.5.2 Using the Application

- Home Page: Access personalized workout plans.
- Progress Tracking: View your workout history and achievements.
- Instructions for Developers
- Backend setup requires Python, Django, and SQLite.
- Use flutter run to test and deploy the Flutter frontend.

4.6 Conclusions

The workout mobile application successfully addresses the need for personalized workout plans and video workout guidance.

Key Accomplishments

AI-powered workout personalization using neural networks and decision trees.Userfriendly mobile app with intuitive UI/UX design.

Limitations

- Limited AI dataset impacts the accuracy of predictions.
- Privacy concerns with user data management.

Challenges

- Limited access to advanced AI hardware.
- Learning curve for integrating AI technologies.

4.7 Recommendations

Based on the conclusions, the following improvements are recommended:

1. Expand the AI training dataset for more accurate workout recommendations.
2. Integrate AR features, such as motion tracking and form correction.
3. Enhance offline functionality for areas with poor internet connectivity.
4. Implement a cloud-based database (PostgreSQL) for scalability.
5. Improve security measures with multi-factor authentication (MFA).

REFERENCES

1. Fitzgerald, G., & Dennis, A. (2019). Systems Analysis and Design.

2. Bishop, C. M. (2006). Pattern Recognition and Machine Learning.

3. Google Developers Documentation for ARCore.

4. Flutter Documentation for Cross-Platform Development.

APPENDICES

1. Instruments: Questionnaire (Appendix A).

2. Letters of Introduction: Supervisor approval letters (Appendix B).

3. Interview Transcripts: User interviews summarized (Appendix C).

4. Project Budget: Detailed budget attached (Appendix D).

5. Project Schedule: Development timeline (Appendix E).