Alistana Fitness & Nutritional Tracker (AFNT)

Application

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# Abstract

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This research aims to address the global health challenge of high obesity rates by developing a secure fitness and nutritional tracker to assist individuals in achieving their health goals. The prevalence of obesity, particularly in developed countries, has led to widespread health and economic implications. This study seeks to raise awareness about the significance of good health, emphasizing the positive mental effects associated with fitness.

The primary objective is to create an accessible software solution that encourages health-conscious behaviour and to increase awareness about the benefits of exercising regularly which can help minimize the healthcare burden and lower the risks of diseases and illness. The relevance of this research is underscored by the urgent need to combat the obesity pandemic and understand its far-reaching consequences on both society and the economy.

The anticipated outcomes include fostering a global culture of health consciousness, where individuals comprehend the profound benefits of good health. The research also endeavours to produce an easy-to-use program, empowering users to navigate their fitness journey effectively. By promoting higher fitness levels, the research aspires to contribute to a healthier population, subsequently mitigating the risks of diseases and alleviating the strain on healthcare systems. This project serves as a comprehensive test of software development and planning skills, aimed at making a substantial impact on public health and well-being.

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# Introduction

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Currently, one of the biggest challenges the world is facing is a global obesity pandemic, which has become an especially acute problem in the developed world. According to The Guardian, around 38% of the global population, approximately 2.4 billion people, are currently categorized as overweight or obese. Without the widespread adoption of measures such as taxing and limiting the promotion of unhealthy foods, this trend is expected to persist. By 2035, it is predicted that the percentage of clinically obese individuals will rise from one in seven to one in four, with more than half of the total population being obese or overweight (Campbell, 2023). Having said that, the rapid increase of obesity rates will lead to higher chances of diseases and illnesses, which will have a greater burden on the healthcare sector and the overall productivity of the economy (‘Obesity Consequences’, 2012).

The key contributors of obesity and overweightness can be summarized to the consumption of high-calorie, fatty foods that are easily accessible, combined with a lack of physical activity (Wright and Aronne, 2012). This research will focus on ways to tackle this complex problem.

The main goal of this research is to develop the Alistana Fitness & Nutrition Tracker (AFNT) program, a free and inclusive application promoting health-conscious behaviour. AFNT aims to raise awareness about the benefits of regular exercise and a balanced diet, reducing healthcare burdens and lowering disease risks, including obesity. The application empowers users to track workouts, nutrition, and body progress securely, ensuring compatibility with mobile and desktop devices.

Maintaining good health and fitness is crucial as it benefits not just physical well-being but mental health as well. Engaging in regular exercise and fitness activities can elevate self-confidence, enhance attractiveness, and foster a health-conscious lifestyle, encompassing balanced nutrition and proper sleep. This holistic approach to well-being not only boosts productivity but also alleviates the financial burden on individuals and the healthcare system at large. By embodying a healthy lifestyle, individuals can inspire others to pursue their fitness goals, thereby fostering a community that values and prioritizes health and well-being.

The outcome:

The report consists of 8 chapters. Chapter 2 provides a critical review of the AFNT Project. Chapter 3 delves into detailed requirements and objectives for the Database Management System (DBMS), AFNT Application, AM Website, and Arduino Watch. Chapter 4 focuses on the Agile methodology used in AFNT development, while Chapter 5 explores AFNT's design architecture. Chapter 6 covers the project's implementation, with Chapter 7 dedicated to its evaluation. Finally, Chapter 8 concludes the report and outlines further work.

# Literature Review

## Technological Advancements and Human Lifestyle

Throughout human history, technological advancements have played a pivotal role in making daily activities more efficient and less labour-intensive. From the invention of tools by Homo habilis to the industrial revolution, innovations like the wheel, carts, and various modes of transportation have transformed the way people live and work (Woessner *et al.*, 2021). The Industrial Revolution further enhanced productivity and ushered in an era of electronic and telecommunications revolution, introducing household appliances that reduced manual labour. Simultaneously, advancements in medicine, spanning over two millennia, have significantly contributed to improved healthcare and increased life expectancy. The twentieth century witnessed breakthroughs such as vaccines, early disease diagnosis, and treatment innovations, resulting in a substantial rise in life expectancy to around 80 years.

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Figure 1: Life Expectancy 10,000 BC - Today (Cato Institute)

However, alongside these benefits, technological proliferation has resulted in a significant decline in incidental physical activity. Everyday activities like active transport and manual labour have been replaced or reduced by technological solutions. The advent of the internet, especially accessible through mobile devices, has further contributed to increased sedentary behaviour, with established associations between internet usage during leisure time and obesity. The overall reduction in physical activity, coupled with a surge in sedentary behaviours, has become a significant factor in the obesity epidemic. Despite technology's positive impact on healthcare and life expectancy, addressing the challenges posed by reduced physical activity remains crucial for promoting overall well-being (Woessner et al., 2021).

Another significant contributor to the rapid increase in obesity rates is the heightened caloric intake, particularly from sweetened beverages, as emphasized by Caballero (2007). These dietary changes, marked by increased consumption of energy-dense foods and a shift away from healthier options, play a substantial role in the current health crisis. The availability of low-cost, easily accessible, and energy-dense food items, combined with changes in dietary patterns, emerges as a prominent factor in the rising rates of obesity. Addressing dietary choices and promoting healthier eating habits are critical components of strategies aimed at combating the obesity epidemic (Caballero, 2007).

Fortunately, technology's ascent has spawned innovative tools for achieving a healthier lifestyle, including mobile phones, smartwatches, and a variety of health and fitness technologies. This market encompasses meditation and workout apps, wearables, connected home gym equipment, Wi-Fi-enabled bathroom scales, and more, offering solutions for weight loss, stress reduction, improved sleep, enhanced immunity, elevated mood, and better nutrition (Moscaritolo, 2024). Additionally, the COVID-19 pandemic accelerated the adoption of health and fitness apps, by gyms closing due to the pandemic, this forced individuals to maintain their well-being from the comfort of their homes. The iOS app market, as analysed by Pankush Kalgotra, Raja, and Sharda (2022), exceeded growth expectations by 29.9%, highlighting the increasing demand for health and fitness-related apps during and after the pandemic.

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Figure 2: Fitness app annual users 2015-2021

## Benefits of an Active Lifestyle

Engaging in regular exercise not only contributes to improved mental well-being, reducing feelings of anxiety and depression, as highlighted by the Mental Health Foundation (2015), but it also plays a pivotal role in weight management by aiding in the burning of excess calories and enhancing metabolism, according to Mayo Clinic (2023). Additionally, exercise has been shown to enhance brain function, safeguarding memory, and thinking skills, thereby promoting overall cognitive health (Godman, 2014). Beyond mental and cognitive benefits, regular physical activity significantly enhances sleep quality, facilitating quicker sleep onset and deeper sleep experiences ('How Can Exercise Affect Sleep? | Sleep Foundation', 2013). Moreover, exercise positively influences the immune system by promoting optimal circulation and facilitating the efficient movement of immune system cells and substances throughout the body ('How to boost your immune system - Harvard Health', 2014). This multifaceted impact underscores the holistic benefits of incorporating regular exercise into one's lifestyle.

## Evolution and Rise of Health and Fitness Tracking

In the present era, digital and wearable health and fitness technologies seamlessly integrate into our daily lives, with smartphones acting as versatile fitness tracking devices. What sets today's technologies apart is their unparalleled personalization. Unlike the mass-oriented approaches of early 1900s entrepreneurs, modern wearables and health apps delve deep into personal tracking, monitoring everything from dietary habits and sleep patterns to movement frequency and body composition (Millington, 2018).

One of the biggest reasons for the high popularity of health and fitness tracking apps can be attributed to the preference for convenience and flexibility, diverging from traditional gym attendance. A study by Better UK (2020) identified reasons such as time constraints, low confidence, crowded gym environments, and familial obligations as factors influencing people to choose fitness apps over gym visits. Despite gyms offering various tools and fitness trainers, the associated expenses, including costly gym membership fees and personal trainers, make these options financially challenging for some (thefitnessgrp, 2023). Consequently, the cost-effectiveness and accessibility of fitness apps, coupled with the opportunity to adhere to expert guidelines, have led to a growing inclination towards utilizing virtual trainers for fitness training at home, accommodating diverse lifestyles and preferences.

Portability has been another transformative factor in the rapid popularity of fitness-tracking apps. In the late 1800s, Charles Wesley Emerson lamented the immobility of exercise equipment like dumbbells. Even in the late 20th century, health and fitness practices were confined mostly to gyms and homes (Millington, 2018). The breakthrough came with smartwatches like Pebble and Apple Watch, offering not just time-telling but also fitness tracking, app integration, and mobile payment capabilities. These multifunctional wearables evolved from niche fitness gadgets to mainstream devices, capturing consumer imagination. In 2009, James Park and Eric Friedman initiated a revolution with Fitbit, launching the Fitbit Classic—a wearable measuring steps, distance, and calories burned. By gamifying the impactful metric of daily steps, Fitbit mainstreamed the concept that anyone can measure health-affecting metrics, and technology can assist in monitoring. Over fourteen years, health and fitness apps burgeoned into a market worth over $8 billion in 2023, attracting nearly 400 million users in 2021 (‘Fitness App Revenue and Usage Statistics’, 2024).

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Figure 3: Fitness in-app purchase revenue by app 2021 ($mm)

Fitbit's success influenced major technology players like Apple and Google to enter the fitness app realm, propelled by the widespread adoption of iPhones and the App Store. The Apple Watch, renowned for gathering intricate biometric data, marked a transformative phase in health tracking with apps and wearables monitoring diverse health metrics, including heart rate, sleep patterns, and stress levels. Apple has extended its tracking capabilities beyond fitness to healthcare, unveiling products like the Apple Watch Series 4 and subsequent iterations. These devices not only track irregular heartbeats but also measure blood oxygen levels, have fall detection, and facilitate automatic emergency calls (‘Healthcare - Apple Watch’, 2017). These technologies demonstrate Apple's commitment to advancing technology for comprehensive healthcare solutions.

Fitness trackers, once simple step counters, have evolved into sophisticated health companions. They now feature comprehensive insights into various aspects of physical well-being, from heart rate monitoring and sleep tracking to GPS navigation. Motivating users through goal setting and progress tracking, fitness trackers incorporate gamification elements, adding fun and competition to the fitness journey. Beyond functionality, these trackers have become fashion-forward accessories, seamlessly integrating with everyday attire for constant monitoring of vital health metrics (Waghchoure, 2023).

## Fitness and Health Tracker Varieties

### Common Categories of Fitness and Health Trackers

**Wearable devices, such as smartwatches and fitness bands, have become highly popular fitness trackers. Companies like Fitbit, Garmin, and Apple offer devices that monitor health metrics like heart rate, sleep patterns, and physical activity. These wearables provide real-time data and insights, making them convenient for daily use. Examples include the Apple Watch, Fitbit, and Garmin devices. As of the first half of 2023, Apple alone holds around 24% of all smartwatch shipments around the globe.**

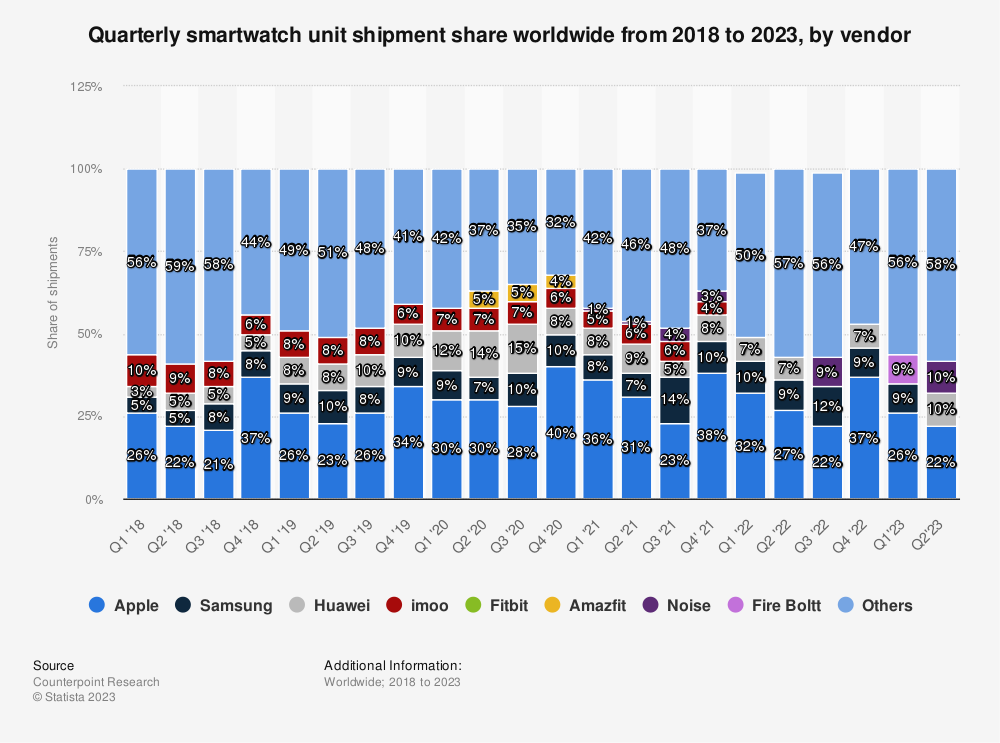
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Figure 4: Quarterly smartwatch shipment share worldwide 2018-2023

**Mobile applications play a significant role in tracking various health metrics. Apps like MyFitnessPal** (‘Calorie Tracker & BMR Calculator to Reach Your Goals | MyFitnessPal’, 2024) **and Nike Training** (‘Nike Training Club App. Home Workouts & More.’, 2023). **Club leverage smartphone sensors and user inputs to monitor activities, nutrition, and overall** wellness **These apps offer customizable features, providing versatile tools for users. Mobile applications can be paired with smartwatches to enhance data collection.**

**Smart scales, another type of fitness tracker, measure weight and often include features like body fat percentage and muscle mass. These scales sync with mobile apps, offering a comprehensive view of body composition and tracking changes over time.**

**These technologies cater to diverse user preferences and needs, providing options ranging from multifunctional smartwatches to straightforward step counters. Platforms like Beachbody on Demand (Beachbodyondemand,** 2023**), and Daily Burn offer on-demand workout videos, personalized plans, and community support, enhancing the fitness tracking experience.**

### Evolving Trends in Fitness and Health Tracking

**Wearable Technology: Leading fitness trackers and smartwatches, such as Fitbit and Apple Watch, utilize advanced sensors to monitor a range of health metrics, including heart rate, sleep patterns, and physical activity. These devices, equipped with GPS technology, can track outdoor activities, and measure additional factors like skin temperature and blood oxygen levels (Fitbit Official Site for Activity Trackers & More, 2023).**

**Machine Learning and AI: My Fitness Pal employs a mobile app featuring Machine Learning (ML) algorithms for personalized workout and nutrition recommendations. Analysing users' workout history, biometric data, and relevant information allows the application to adapt and offer more effective, tailored suggestions (Calorie Tracker & BMR Calculator to Reach Your Goals | MyFitnessPal, 2023).**

**Natural Language Processing (NLP): Virtual assistants like Apple’s Siri and Google Assistant utilize NLP technology to interpret and respond to voice commands, facilitating hands-free operation of fitness apps during workouts.**

**Computer Vision: In workout apps, Computer Vision technology ensures users maintain proper exercise form. By analysing video data, computer vision algorithms provide real-time feedback on exercise techniques, promoting correct form.**

**Internet of Things (IoT): Peloton integrates fitness equipment with IoT technology, enabling real-time workout tracking and data synchronization with health and fitness apps (Peloton® | Workouts Streamed Live & On-Demand, 2023).**

## Effectiveness of Fitness Trackers

Wearable activity trackers have emerged as cost-effective tools to combat physical inactivity. A comprehensive review of 39 systematic reviews and meta-analyses, spanning diverse populations, demonstrated the positive impact of activity trackers on physical activity, body composition, and fitness, resulting in approximately 1800 extra steps per day, 40 additional minutes of walking, and about 1 kg reduction in bodyweight (Ferguson et al., 2022).

In a single case study, the effectiveness of a wearable fitness tracker, specifically a Fitbit, was explored in a 36-week intervention program for an overweight, type 2 diabetic, geriatric subject. The integrated use of the Fitbit reported qualitative improvements in active minutes, steps taken, miles walked, calorie intake, sleep duration, and liquid consumption. The subject significantly increased daily walking distance from less than one mile to over 4.6 miles, nearing the recommended 5 miles per day goal. The technology facilitated continuous monitoring by the healthcare team, showcasing positive changes in exercise dedication and overall well-being (Thomas William Miller, 2017).

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Figure 5: Variables measured over a 36-week study for Type 2 Diabetic patient using Fitbit (Thomas William Miller, 2017).

Moreover, another case study that involves a virtual fitness trainer app, assessed through the Situational Motivational Scale (SIMS) with 54 students, demonstrated effectiveness in motivating and engaging users in fitness activities. The app's virtual trainers positively influenced students' motivation, making the activities enjoyable and beneficial for their fitness levels. Respondents found the activities interesting, fun, and essential, highlighting the app's potential to enhance engagement and motivation in fitness-related endeavours (Mokmin and Nurullizam Jamiat, 2020).

In summary, the evidence suggests that wearable fitness trackers, exemplified by Fitbit and virtual trainer apps, play a crucial role in enhancing physical activity, motivating users, and positively impacting overall health and well-being.

## Risks of Fitness Trackers

Fitness tracker apps, with their extensive data collection and sharing capabilities, introduce significant privacy and security risks. A survey of 11,000 mobile health apps, representing 5,000 developers, reveals that fitness and nutrition apps are particularly advanced in sharing user data via shared application programming interfaces (APIs) (‘Permissions on Android’, 2024). Sharing commonly occurs with data aggregators like Apple’s HealthKit, wearables, and directly between apps (Grundy, Held and Bero, 2017).

These apps serve diverse functions, accessing vast amounts of highly personal data, including location, text messages, and even camera or photo access (Olmstead, 2015). The inherent access to personal health information heightens privacy risks, with concerns about data being shared with third parties, including advertisers and data brokers (Grundy, Held and Bero, 2017)

The risks extend to information leaks, manipulation, and loss, as demonstrated by Li's privacy threat model (Li, 2015). User profiling across multiple sites can lead to aggregated user profiles, monetized for marketing, or even exploited for identity fraud (Grundy, Held and Bero, 2017).

Mobile health apps, including fitness trackers, routinely request numerous permissions, indicating a broad spectrum of data access. The most common permissions relate to internet access, with implications for data transmission and sharing (Grundy, Held and Bero, 2017).

Privacy risks are exacerbated by unencrypted network connections, a common feature in health and fitness apps. This exposes private health information to potential interception by malicious actors, contributing to concerns about data security (Humer and Finkle, 2014).

Despite these risks, the regulatory landscape for mobile health applications remains largely unregulated, leaving consumers vulnerable. The unclear, irrelevant, or nonexistent privacy policies in many apps contribute to the challenges of safeguarding user privacy (Grundy, Held and Bero, 2017).

In conclusion, the risks associated with fitness tracker apps include extensive data sharing, potential exposure of sensitive health information, and inadequate privacy policies. User awareness, transparent practices by app developers, and regulatory measures are crucial for addressing these privacy and security concerns.

## Ethical Considerations

In developing the AFNT app, ethical considerations play a crucial role in ensuring user trust and data security. The app must prioritize data privacy by complying with GDPR (‘Overview of UK GDPR’, 2016) and implementing secure storage and transmission measures. Intellectual property rights are respected, necessitating proper licensing for third-party content. Accessibility is a key focus, with the app designed to be inclusive and user-friendly for individuals with disabilities following WCAG guidelines (WCAG 2, 2018). Security measures are implemented for the DBMS and ensure encrypted data transfer from the Arduino watch. Hardware standards for the Arduino watch prioritize user safety and comfort. Battery optimization features guarantee prolonged operation, and both the website and app adhere to accessibility standards and offer a user-friendly interface. Compatibility across various mobile platforms and seamless integration with mapping APIs further enhance the app's ethical usability and accessibility.

## Development Research Plan

Embarking on the AFNT Fitness Tracker development necessitates a thorough grasp of technical nuances in each project component. A comprehensive understanding of challenges, tasks, and effective management approaches is crucial. Due to the extensive nature of the AFNT project, it will be initially segmented into five planning stages, as outlined in Figure 6: AFNT Fitness Tracker Intial Questions..

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Figure 6: AFNT Fitness Tracker Intial Questions.

### Technical Knowledge

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Figure 7: AFNT Project Phases

Phase 1 involves setting up a Database Management System (DBMS) with Central (CDB) and Local (LDB) databases (Phase 1.5). User data is stored locally, accessible only to the user, while CDB stores predefined workouts, meals, and user login credentials for secure login. Phase 2 introduces the Admin Management Website (AM) responsible for maintaining CDB and pushing updates to AFNT. Phase 3 focuses on developing the AFNT application, allowing users to monitor workouts, meals, and body data. Phase 4 extends Phase 3 by introducing the Arduino Fitness Watch, capable of monitoring health metrics and seamlessly transferring data to the AFNT application via Bluetooth or a wired connection. We will delve deeper into each phase in the next chapter.

This includes expertise in database management systems, server technologies, mobile app development, Arduino-based hardware, and design tools. Technical knowledge encompasses proficiency in utilizing SQLite for the local database, Microsoft SQL Server for the central database, Kivy module for cross-platform app development, Bluetooth technology for data transfer, Astah UML tool for system design, and graphical tools like Paint for UI sketches.

### Domain Knowledge

### Requirements Gathering

### Technologies Used

### Success Criteria

The implementation of a comprehensive workout tracking and health monitoring system, including personalized workout plans, nutritional tracking, and health advice, will lead to improved physical fitness, increased adherence to exercise routines, and enhanced overall well-being among users.

# Requirements

# Methodology

# Design

# Implementation

# Project Evaluation

# Further Work and Conclusions

# Glossary

# Table of Abbreviations

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# Appendix A: First Appendix