FINAL YEAR PROJECT REPORT

Fitness App

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Module: Individual Project (CS3IP)

Date: 24/04/2023

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Acknowledgement

First, I would like to thank my main supervisor, Tony Beaumont, who guided and supported me throughout the development project and also responded promptly to my emails.

I would also like to thank everyone who tested my app and provided me with insightful feedbacks during the testing and evaluation phase.

Finally, I would like to thank Aston University for providing me with the chance to demonstrate my abilities and acquire valuable experience by enabling me to apply everything I have learnt over the past three academic years to this project.

Signed: Omar Sillah

Abstract

The objective of the project was to develop a fitness app for Android smartphones and smartwatches that encourages users to exercise by providing fitness tracking features and motivational tools.

Extensive background research was conducted to evaluate and comprehend existing systems and research papers on the advantages of smartwatches and fitness applications, which was detailed in the section on background research. The report examines briefly the design and development of the system, the decisions made, the tools used, the methodology followed, the design and development of prototypes, and the problems encountered.

In the report's section on testing and evaluation, several standard testing procedures were used and described.

The conclusion, as well as the advantages and disadvantages of the system, were discussed in the final section.

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1. Chapter 1: Introduction

1.1 General Introduction

Physical activity has been associated with numerous health benefits, such as enhanced cardiovascular health, weight management, and a reduced risk of chronic diseases such as diabetes and cancer.

However, many individuals struggle to maintain a consistent exercise routine due to a lack of motivation, hectic schedules, or other factors.

In the past year, 34% of men and 43% of women did not engage in strenuous weekly activity such as running or gym sessions, according to research conducted by the Nuffield Health charity on 8000 UK citizens and reported by The Guardian (2022).

Sixty percent of respondents to a poll conducted by Nuffield Health, which was published in the Guardian(2022), cited a lack of motivation as a barrier to exercise, while a third cited not knowing where to start.

In recent years, the proliferation of fitness apps and smartwatches has given individuals a new method to track their physical activity and fitness objectives.

These technologies provide a variety of features, such as step tracking, heart rate monitoring, and exercise history, which can assist users in remaining accountable and motivated throughout their fitness excursions.

The use of fitness applications and wearables has been shown to have substantial benefits for physical activity and overall health. Those who used fitness applications were more likely to engage in regular physical activity and had improved health outcomes than those who did not (Conroy et al., 2014).

Another study published in the International Journal of Environmental Research and Public Health linked the use of wearable fitness monitors to increased physical activity and better weight management in overweight and obese individuals (Wang et al., 2021).

Several studies have examined the benefits of goal setting in fitness applications, and the findings indicate that goal setting can improve motivation, adherence, and overall fitness outcomes.

Conroy et al. (2014) reported in the Journal of Medical Internet Research that setting goals, challenging objectives in a fitness app was associated with substantial increases in physical activity and improved fitness results over a 12-week period.

According to research from the International Journal of Sport and Exercise Psychology that was published on ResearchGate, the group that set goals scored significantly higher on interest, enjoyment, and perception of choice, significantly lower on perceived pressure, and had significantly higher adherence than the outcome goal and control groups (Wilson & Brooks, 2009).

The purpose of the study was to determine how setting goals affected participants' motivation and adherence throughout a six-week programme. There were a total of 60 participants, 33 men and 27 women.

Smartwatches have the potential to reduce the number of sedentary individuals and increase their motivation. As technology continues to develop, it is likely that smartwatches will become even more effective fitness and health monitoring devices.

1.2. Project Scope

This project entails developing a fitness tracking app that utilises a smart wearable device to gather information about the user's activities and store the information on the smartphone app.

These comprise the number of steps performed, the distance travelled, the pace, heart rate information and calories burnt.

Users will also have access to a chart, which will make it simple for them to keep track of their progress.

The fitness app also includes two activities , walking and running.

The purpose of the fitness app is to inspire users to set desired objectives and support them in achieving those goals.

Specific gym workout regimens like weightlifting exercises and pre-plain workout routines won't be offered by this fitness app.

The project's goal is to develop a useful fitness monitoring smartwatch app that integrates nicely with the smartphone app that will be used to store the user's activities.

1.3. Project Summary

Aim

The aim of the project is to develop a fitness app that can track several sensors accurately while exercising.

Objectives

I. Feasibility study and report will be developed to determine if the project is feasible and can be completed .
II. A Gantt chart will be created using Microsoft Visio software and all the tasks that need to be done will be available .
III. Developing two prototypes by early march.
IV. Complete the design phase by the end of march.
V. Complete the user interface by the end of march.
VI. Complete the development of the basic features in both the smartphone app and smartwatch app.
VII. Testing will be done using the black box, white box testing and user testing.
VIII. Finish the report by the end of April.

1.4. Structure of Report

The structure of this report is as follows:

<u>Chapter 2 Background</u>:

The background section consist of project elaboration , wearable , similar existing systems and sensors .

The Background section primarily focus on the initial research aspect of the project.

<u>Chapter 3 Design</u>:

The design section contain the methodology that is being used and why I choose it over other methodologies. It also consist of tools and technique used, gathering user requirments, and a variety of different diagrams.

<u>Chapter 4 Development:</u>

This section consist of showing prototype development and critical codes

<u>Chapter 5 Testing:</u>

The testing section consist of specifying whether the system have met the user requirments or not. White box testing, black box testing, and user testing are performed to determine whether or not user requirements have been met.

<u>Chapter 6 Evaluation:</u>

The evaluation section consists of a discussion of the finding from the user testing results ,white box and black box testing and an evaluation of the future system improvements.

<u>Chapter 7 Conclusion:</u>

This section consist of evaluating the features implemented, project achievement and drawbacks, and the lesson learnt during the whole development of the project .

2. Chapter 2 Background

2.1. Project overview

Android and iOS dominate mobile app development.

Before creating a mobile app, you must decide if you want to develop specifically on IOS or Android or both.

My senior thesis will be an Android fitness app as Multi-platform development will be out of scope for this project.

Market share, versatility, programming language, and distribution cost drove Android fitness app development above IOS.

Android has 71% market share worldwide (Taylor, 2023) .

This shows that Android is used by most mobile users globally, making Android fitness apps more realistic.

Android is more flexible than IOS due to having a less limited environment. Java, a flexible programming language for Windows, Mac OS, and Linux, may be used to construct Android apps.

This allows developers to build Android apps independent of the device's operating system, unlike IOS, which uses Swift, an Apple-exclusive programming language.

Google offers mobile app development tools like Jetpack. Android Studio comes with Android SDK.

2.2. Wearable

In this section, I will discuss some of the most important literature review findings regarding the health benefits of smartwatches.

2.2.1. Smartwatch health benefits

The health care sector is embracing smartwatches as essential technology as the number of wearable devices as increased in recent years from 400 million in 2016 to over 1 billion in 2022 reported by Laricchia, F. (2022) .

According to a large scale review published in the Lancet Digital Health by University of South Australia (Unisa, 2022),researchers found that tracking your activities motivates you to walk up to 40 minutes more per day and take approximately 1800 more steps than those who do not track their activity, resulting in a weight loss of more than 2.2 pounds (1 kg) over 5 months.

In the studies, participants of any age used an activity sensor, such as an accelerometer, activity monitor, or pedometer, to encourage more physical activity.

The studies involving 164,000 participants found that fitness monitors not only encourage exercise and weight loss, but also reduce blood pressure and cholesterol in individuals with type 2 diabetes and other diseases.

In conclusion, activity monitors appear effective at increasing physical activity in a variety of age groups; consequently, their use is recommended.

The step counter, pulse rate, and calories burnt features allow users to begin exercising and achieve their daily fitness objectives.

A journal article published by the NIH (Dunn et al., 2021) that examines the significance of data collected from smartwatches may be advantageous. The study was conducted on 54 participants over the course of three years, during which time they were required to attend the clinic 40 times and wear a wristwatch for 340 days.

The smartwatch measured vital information including heart rate, number of steps, skin temperature, and other sensor data.

When evaluated in a clinical setting, the researchers (Dunn et al., 2021) discovered that temperature measurements were more consistent; however, they also discovered that the smartwatch provided more accurate heart rate readings as the heart rate is routinely measured throughout the day.

Researchers(Dunn et al., 2021) also sought to determine if the data collected from the devices sensors could be used for clinical laboratory tests by comparing the predicted results to those of clinical laboratory tests.

The researchers (Dunn et al., 2021) determined that the predictions were comparable to clinical test results and concluded that the data from wearables are not a replacement for clinical tests, but could be useful for providing early warning signals such as heart rate.

However, this capability is not included in the scope of this project.

The wristwatch saved the life of a 54-year-old man named Dave Last after it repeatedly alerted him to his low, irregular pulse rate, as reported by The Sun(Connor, 2022).

This is just one instance in which watches have alerted wearers to vital health information, potentially sparing their lives.

Smartwatches may assist you in setting and achieving fitness objectives, which can enhance your workouts when the sport mode is activated.

As early disease detection and preventative treatment can prevent a disease from worsening by alerting users to their health irregularities, smartwatches have the potential to reduce global health care costs.

According to a study conducted by WHOOP (Miller et al., 2020), the model was able to identify 20% of COVID-positive cases two days before symptom onset and 80% of cases by the third day of symptom onset based on respiratory rate during sleep. To predict Covid infection, the model was trained with previous data on respiratory rate and other indicators of heart function from a cohort of persons with COVID. The research indicates that COVID detection using smartwatch sensors is feasible, but doing so is beyond the scope of the project.

In conclusion, smartwatches are excellent instruments for enhancing lifestyles, encouraging users to achieve their fitness objectives, and possibly preserving lives.

2.2.2. Android fitness Smartwatches

When selecting an Android wristwatch fitness device, you should strive for a balance fitness smartwatch that will aid in your routines, but you should also consider the device's quality, price, battery life, and design.

There are a variety of Android Smartwatches on the market, some of which are superior to others, but the vast majority of the most recent models have circular, visually identical designs and run Wear OS.

I'll use the Samsung Galaxy Watch 5 Pro as an example of a decent Android smartwatch and compare it to Fitbits and IOS smartwatches.

Samsung Galaxy watch 5 and 5 pro

Samsung Galaxy Watch 5 and Watch 5 Pro are the best Wear OS watches(Samsung, 2023).

Bunton (2022) says the galaxy watch 5 pro achieves the right combine between price, performance, and features.

Samsung Galaxy Watch 5 and 5 Pro run Google Wear OS and has a minimalistic and round shape. The Galaxy Watch 5's elegant user interface lets users operate the device with swipes, taps, and button pushes.

Strava, Google Fit, and other amazing fitness apps are available on the Samsung Galaxy Watch 5 and 5 Pro.

The Galaxy Watch 5 and 5 pro measure heart rate, blood oxygen levels, and bioelectrical impedance analysis.

It can detect blood pressure and track sleep using a temperature sensor. The BIA sensor measures your body composition, including skeletal muscle mass, hydration, body composition, and more.

The Galaxy Watch 5 and 5 Pro have sharp super AMOLED screens that can withstand bright outside situations(Samsung, 2023).

The galaxy watch 5 pro has a three-day battery life, which is suitable for fitness smartwatches, whereas the galaxy 5 has a one-day battery life. The galaxy watch 5 pro is

tailored for Samsung phones since the ECG cardiac analysis capability is limited to Samsung phones(Samsung, 2023).

Galaxy Watch 5 Pro, albeit more costly, is the better alternative. The Galaxy Watch 5 Pro outperforms the Galaxy Watch 5 due to its bigger battery, increased durability, and unique features.

Figure 1 Samsung Galaxy watch series 5

2.2.3. IOS Smartwatches

The Apple Watch Series 8 is widely regarded as one of the finest available premium wearable watches (Apple, 2023).

The Apple Watch Series 8 is the best fitness tracker and smartwatch hybrid, according to Moscaritolo (2022), due to its wide range of built-in fitness, health, and safety features, as well as its vast selection of third-party applications.

The number of advantageous health and safety features, such as the new collision detection feature, that the Apple Watch Series 8 provides to customers led Kozuch (2022) to rank it as the best smartwatch overall.

The Series 8 Apple Watch has a large rectangular design with tapered edges and a brightness of 1000 nits. The display is an outstanding OLED screen with a simple user interface.

According to Apple(2022), the Apple Watch Series 8 has a battery life of up to 18 hours and a new Low Power Mode that extends it to up to 36 hours.

The Series 8 Apple Watch can monitor your activity, blood and oxygen saturation (Sp02), body temperature variations, fertility windows, menstrual cycle, nocturnal respiration, and sleep.

It can also notify you if it detects an irregular heartbeat, an erratic heartbeat, or noises that could cause hearing loss.

In addition, it supports Emergency SOS and international emergency dialling and can contact for assistance when a significant fall is detected. Moreover, if you do not respond, it may identify an accident and summon for assistance.

Figure 2 Apple Watch series 8

2.2.4. Fitbit Smartwatch

The Fitbit Versa 4 is a reliable, affordable smartwatch-style fitness tracker with a wide range of features(Fitbit, 2023).

The Fitbit Versa 4's square, rounded-corner aluminium body is waterproof to 50 metres, making it suitable for swimming.

Fitbit tracks steps, heart rate, sleep, GPS, SpO2, and temperature (at night).

The Fitbit Versa 4 is less accurate than an Apple Watch Series 8 (Williams, 2022) for runners, but its battery life is better. Fitbit (2022) says the battery lasts 6 days and up to 3 days in always-on display mode, unlike competing smartwatches like the apple watch series 8 and the galaxy watch 5.

The Fitbit Versa 4 does not support third-party apps, which may disappoint customers since you can't workout without a phone and lose music playing.

Williams, A. (2022) says the Fitbit is good for beginners but lacks the smart features of the finest Apple Watch models, such the series 8.

FitbitOS makes the Versa 4 compatible with Android and iOS phones, unlike Apple Watches and Samsung Galaxy Watches. This functionality is useful for Android-to-IOS converters.

Figure 3 Fitbit Versa 4

2.2.5.Compare Android ,IOS and Fitbit smartwatches

In this section, I will compare the design, the health and safety sensors, battery life and compatibility of the galaxy watch 5 pro ,apple watch series 8 and Fitbit versa 4.

2.2.5.1. Design

The Fitbit Versa 4 and the Apple Watch Series 8 both have rectangular designs, in contrast to the circular shape of the Samsung Watch 5 Pro.

Due to their small displays and the inability of smartwatches to display all information, the apple watch series 8, Fitbit versa 4, and galaxy watch 5 pro work best with a smartphone. The majority of information is displayed on the smartphone app.

As information can be shared between the smartphone and wristwatch applications, smartwatch applications that are linked with a smartphone application typically provide more information.

Consequently, smartwatches that utilise both the smartphone and smartwatch's capabilities.

Before you can transfer data between your smartphone and wristwatch, you must establish a Bluetooth or Wi-Fi connection between the two devices.

The construct and operate wearable apps section of the official Android developer page offers guidance on how to synchronise a real watch with a phone emulator or a real smartphone with a watch emulator, but not a real smartphone and a real smartwatch.

A YouTuber (HackVeda Limited, 2021) provided an excellent tutorial on how to use the Wear OS software and Android Studio's built-in terminal to synchronise your smartphone and wearable via Bluetooth.

After the smartphone and wristwatch have been synchronised via Bluetooth, a connection must be established between them in order to exchange data.

The official Android developer website's Handling data section contains some useful information about exchanging data and the various methods, but it is missing crucial information (Develper, A., 2023).

Hahn (Android Wear Documentation,2015) provides a fantastic lesson on how to communicate a large quantity of data back and forth, along with a thorough explanation.

Smartwatches are utilised not only for monitoring capabilities and GPS to track your location and devices, but also for quickly accessing notifications, answering phone calls, and sending and reading text messages using the integrated voice assistant.

Smartwatches can be used for media management when listening to music(Silbert, 2023), as volume and song selection can be controlled without the need for a smartphone.

In addition to having a smaller screen than smartphones, smartwatches also have less memory. Consequently, smartwatches cannot store as much data as smartphones, which is why the majority of data in smartwatches applications are typically stored in smartphone applications.

Due to their small screen size, limited memory, inferior CPU performance, and low ram memory, smartwatches have an app store that is more limited than that of smartphones.

As a result, smartwatches are optimised for use as a companion to smartphones, rather than as a replacement, as their functionality may be limited if used as a phone replacement.

2.2.5.2. Health & Safety Sensors

Both the Apple series 8 and the Samsung Galaxy watch 5 Pro have cutting-edge health and fitness features, but only the Apple series 8 has vehicle accident detection.

Fitbit is essentially an intelligent fitness tracker, so the Versa 4 includes a variety of fitness monitoring functions.

Anfield (2022) asserts that the Apple Watch 8 has a minor advantage over the Fitbit Versa 4 in terms of sensor capabilities, despite the Fitbit Versa 4's numerous sensors.

The Galaxy Watch 5 pro supports over 90 sports modes, which is more than twice as many as the Fitbit Versa 4's 40.

Similar to the Apple Watch Series 8 and Fitbit Versa 4, the Samsung Galaxy Watch 5 Pro includes a skin temperature sensor; however, Samsung has not yet activated it. In contrast to the Series 8 and the Versa 4, the Galaxy Watch 5 Pro can import GPX-formatted exercise routes and trace back mapping.

2.2.5.3. Battery life

One of the main considerations for consumers when choosing a smartwatch is battery life.

DSOUZ, R.I.S.H.A.D. (2022) reports that a global YouGov study done in August revealed that 65% (or two-thirds) of customers worldwide cite battery life as the most important

consideration when choosing a smartwatch. According to the poll, 72% of respondents in Great Britain, rated a smartwatch's battery life as its most crucial feature.

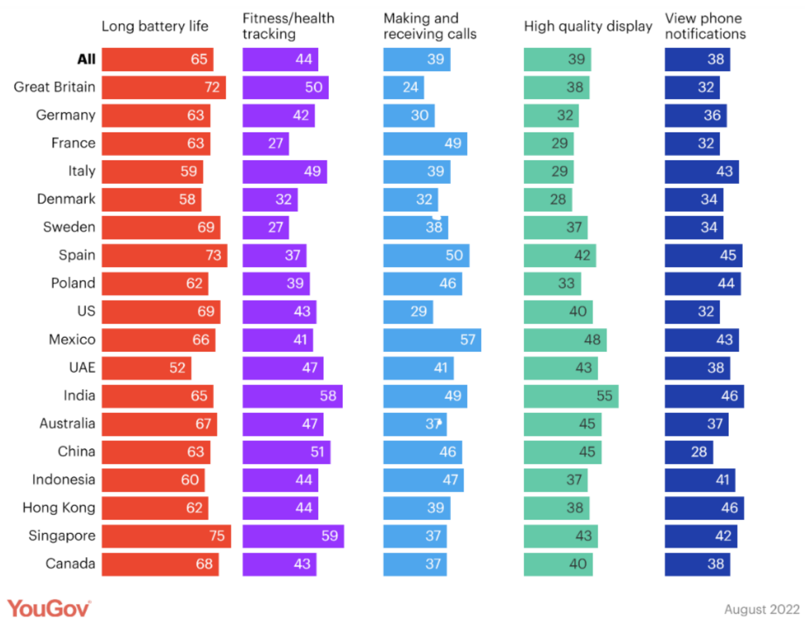


Figure 4 The most important features on a smartwatch

Unfortunately, the new Low Power Mode on the Apple Watch 8 only improves the battery life to up to 36 hours(Apple,2022), which is not regarded as a fantastic battery life for smartwatches. The battery life of the Galaxy Watch 5 Pro, on the other hand, is greater, offering a practical battery life of 3 days but a potential of 80 hours.

However, the Fitbit Versa 4 has an even greater battery life, lasting 6 days and up to 3 days in always-on display mode.

Due to its longer battery life than the other two smartwatches, the Fitbit Versa 4 is seen by many consumers a great choice for outdoor activities.

2.2.5.4. Compatibility

Wear OS is installed on the Samsung Galaxy Watch 5, and applications are downloaded from the Google Play Store. While the Apple Watch 8 operates on watchOS 9, which offers a vast selection of third-party applications, the Fitbit Versa 4 operates on Fitbit OS and provides consumers with a large selection of apps and watch faces via the Fitbit Gallery.

The Fitbit is compatible with both iOS and Android phones, which may be convenient for people who frequently transition from Android to iOS devices or vice versa.

It does not, however, support third-party applications, which is problematic given that the apple watch 8 and the galaxy watch 5 both offer a vast selection of such applications.

2.2.5.5. Conclusion

The Apple watch series 8 offers an extensive range of precise fitness, health, and safety features, including collision detection, that the Fitbit versa 4 and the Samsung Galaxy Watch 5 do not.

Apple Watch Series 8 is less suitable for outdoor activities such as hiking, cycling, and marathons than the Fitbit Versa 4 and Galaxy Watch 5 Pro due to its limited battery life.

The Fitbit Versa 4 is the best choice for outdoor activities such as marathon running, cycling, and hiking. However, it lacks support for third-party applications and several ingenious features offered by the apple watch 8 and Samsung watch 5 pro.

Additionally, the Galaxy Watch 5 Pro has a substantially extended battery life than the Apple Watch 8. The apple watch 8 has more fitness, health, and safety features, such as collision detection, than the galaxy watch 5 pro.

2.3. Similar System

In this section, I will examine a selection of relevant apps chosen for their popularity and similarity to the system I intend to design and implement.

2.3.1. Strava

Strava is a popular fitness tracking app that allows users to record their workouts, analyse their performance, and communicate with other athletes. A premium version of the app is available on iOS and Android for a monthly or annual fee.

The app's interface is user-friendly and easy to navigate, and it offers numerous customization options to accommodate a variety of preferences and needs.

Social features are one of the primary benefits of Strava. Connecting with others, joining organisations, and engaging in competitions can be an excellent source of motivation for remaining physically active.

Some features, such as advanced exercise analysis and training programmes, are exclusive to the premium version of Strava.

Not available in the free version are sophisticated features such as customised coaching, detailed exercise analysis, and real-time GPS monitoring. In addition, it allows users to set goals and track their progress over time, as well as access to exclusive challenges and discounts on goods.

Strava is a useful application for tracking exercises and networking with other athletes. While the free version offers a variety of features, serious athletes may desire to upgrade to the paid version for more advanced monitoring and training options.

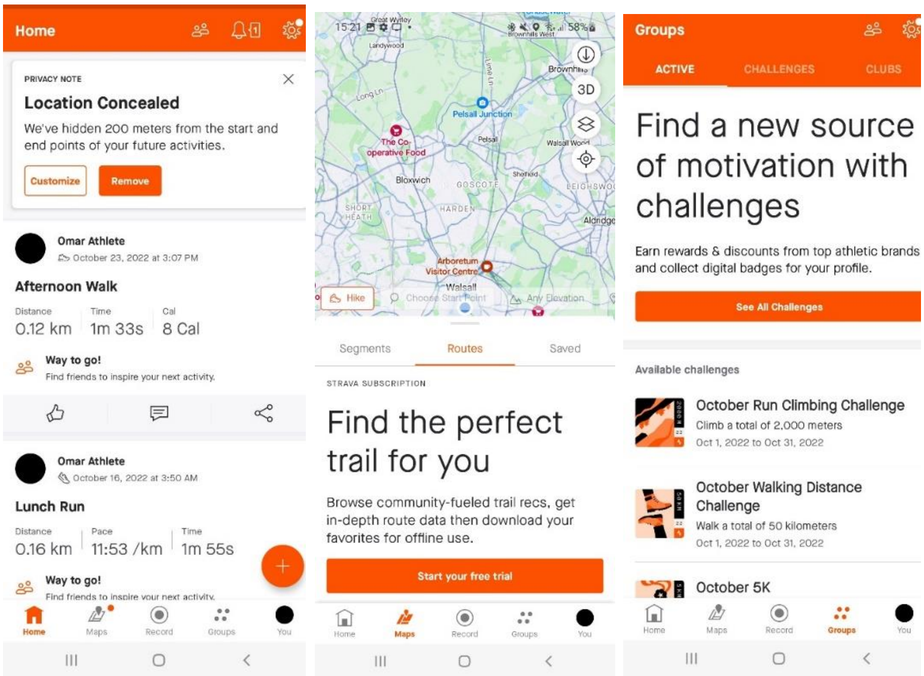


Figure 5 Strava smartphone app

Figure 6 Strava Smartwatch app

2.3.2. Google Fit

Google Fit is a common fitness tracking app for Android and iOS devices that was developed by Google. The application enables users to record their daily physical activity, establish fitness objectives, and track their progress over time.Google Fit's seamless integration with other Google services, such as Google Maps and Google Calendar, is one of its strengths. The app can autonomously monitor and record a user's physical activity using data from the device's sensors and other sources, such as fitness trackers worn by the user.

Google Fit's interface is renowned for its simplicity and intuitiveness. The app is user-friendly and provides a variety of customization options, including the ability to set activity objectives and modify activity monitoring settings.

Some other fitness tracking apps may offer more advanced features than Google Fit, like a detailed workout analysis or counselling.

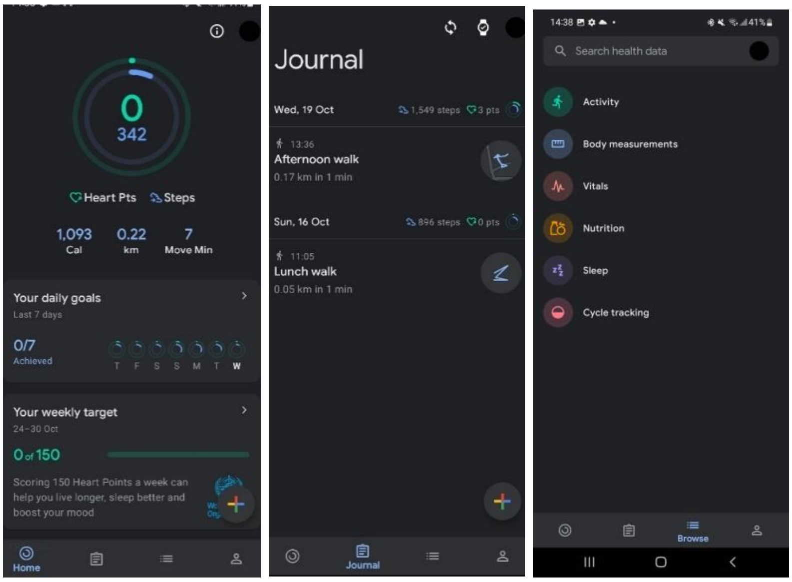


Figure 7 Google Fit smartphone app

Figure 8 Google Fit Smartwatch App

2.3.3. Adidas Running

The Adidas Running app is a popular fitness tracker app that is available for free on Android and iOS devices.

The free version of the Adidas Running app offers rudimentary tracking, personalised coaching, and access to challenges and social features, whereas the premium version offers more advanced tracking, coaching, and analytics options, as well as an ad-free experience.

Regarding usability, the Adidas Running app is known for its streamlined and intuitive user interface. The application has numerous configurable settings and features to accommodate different user preferences and needs.

Some users may find the Adidas Running app's interface to be somewhat cluttered or overwhelming, especially those who are new to fitness monitoring or running.

The Adidas Running app is a great choice for runners who desire to track their progress, communicate with other athletes, and gain access to a variety of training and coaching options. It may not be the most intuitive app for beginners or those who prefer a minimalist interface, but its advanced features and social connectivity options make it a popular choice among serious runners.

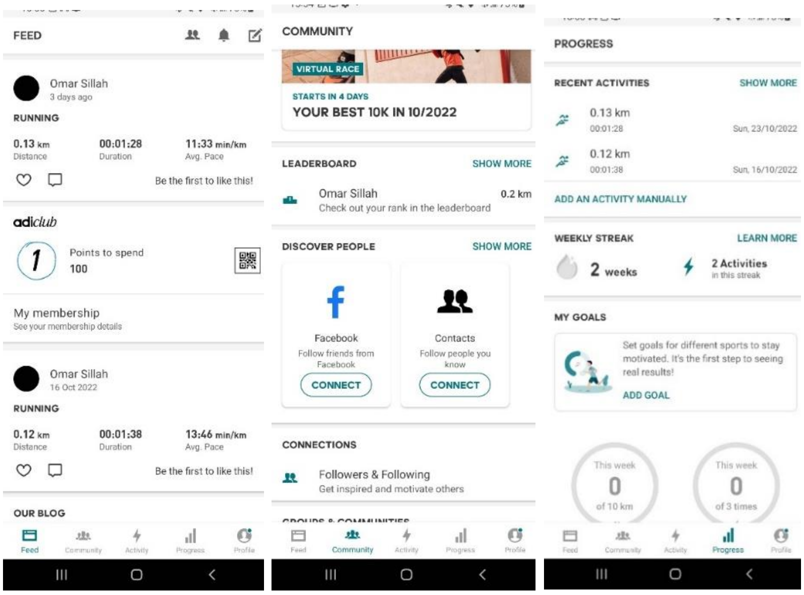


Figure 9 Adidas Running smartphone App

Figure 10 Adidas Running smartwatch App

2.3.4. ActivityTracker

The ActivityTracker app is an iOS and Android-compatible pedometer designed to help users track their physical activity and monitor their health and fitness objectives.

The user-friendly interface of the ActivityTracker app makes it simple to navigate and use.

While the ActivityTracker app has a number of advantageous features, there are potential drawbacks to consider.

The premium version of the app, which includes features such as personalised coaching and detailed workout analysis, can be costly. This may discourage some users from upgrading, particularly those seeking for a more affordable fitness app.

According to NHS(2023) Inform, walking enhances health and reduces the risk of developing melancholy.

Regular walking reduces the risk of chronic diseases such as heart disease, stroke, asthma, and obesity.

The NHS recommends 150 minutes of moderate activity per week for people aged 19 to 64, and a daily 10-minute vigorous walk has numerous health benefits. In this instance, walking at three kilometres per hour is strenuous.

According to a journal article from the National Library of Medicine, healthy individuals take between 4,000 and 18,000 steps per day, with the average being 10,000.(Tudor-Locket al.,2011).

They cautioned that older individuals and those with chronic diseases may have difficulty reaching 10,000 steps per day.

ActivityTracker is a pedometer programme, so it encourages people to walk, which is recommended by the NHS.

Figure 11 ActivityTracker smartphone App

2.3.5. Exercise Timer

Exercise Timer is a fitness app that aims to keep users on schedule with their workouts by offering customizable timer and interval features.

The user interface of the Exercise Timer app for smartphones is well-designed and intuitive, whereas the smartwatch is less optimised.

The smartphone application's interface is clear and minimalist, making it simple to locate and customise the required settings. Users can customise the font size, colour, and sound effects to their liking, and the app includes a voice-over function that announces the beginning and ending of each interval.

While the smartwatch app is less well-designed and less user-friendly, which is more disappointing.

The application provides a variety of preset regimens, such as HIIT and Tabata, but also enables users to construct their own custom workouts with timer and interval settings. This allows users to tailor their exercises to their specific requirements and preferences, making it simpler to remain motivated and reach their fitness objectives.

Some users may find the free version of the Exercise Timer app to be somewhat limited, which is a possible drawback. While the free version offers fundamental timer and interval functions, the paid version grants access to a greater number of advanced settings and customization options. For users who are dedicated to their fitness regimens, the premium version may be an investment worth making.

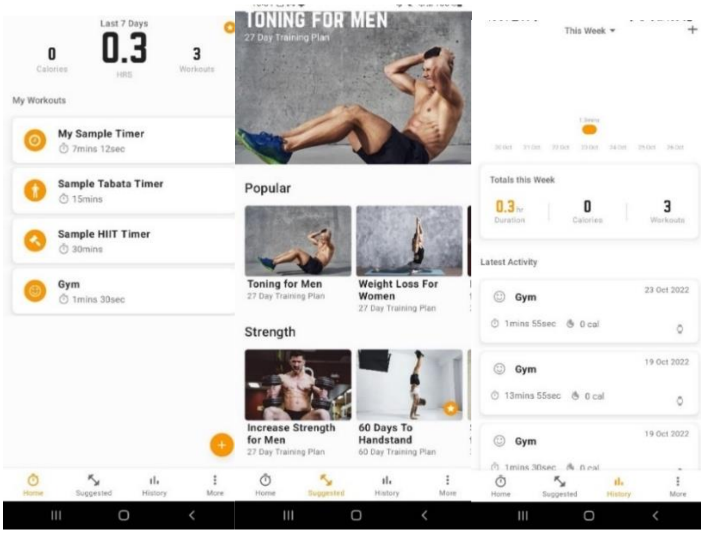


Figure 12 Exercice Timer smartphone App

Figure 13 Exercise Timer smartwatch App

2.3.6. Analysis Review

	Google Fit	Strava	Addias Running	ActivityTracker	Exercise Timer
Track your heart rate	Yes	Yes	Yes	No in the smartwatch app	Yes
Advance tracking heart rate features	No	No	No on the free App ,Yes on the premium app	No	No
Counting your steps	Yes	No	No	Yes	No
Calculate your calories burnt	Yes	Yes	Yes	Yes	Yes
Track your pace and distance while exercising	Yes	Yes	Yes	Only the distance	No
Offering different Activities	Yes	Yes	Yes	No	Yes
Profile page	Yes	Yes	Yes	No	No
Progress page that store your recent activities	Yes	Yes	Yes	No	Yes
Basic Analysis charts	Yes	No	Yes	No	Yes
Advance graphs charts	No	No	No	No	No
Organise weekly routine	No	No	No	No	Yes
Feed and suggestion page	Yes	Yes	Yes	No	Yes
Companion app	Yes	Yes	Yes	No	Yes
Built-in map and GPS	No	Yes	Yes	No	No
Social media	No	Yes	Yes	No	No
Groups and Community	No	Yes	Yes	No	Yes
Challenges	Yes	Yes	Yes	No	No
Free App	Yes	Yes	Yes	Yes	Yes
Extra unique features	Heart point ,tracking sleep and breathing exercise	the use of segments which are timed section created by users	Adding music playlist for running in the app	No	No

Table 1 Analysis review

From the comparison table, it can be deduced that apps like Google Fit, Strava, and Adidas Running offer more features and distinctive qualities than other fitness-related apps previously reviewed.

Apps such as ActivityTracker and exercise Timer lack numerous useful features, such as an integrated map and GPS and challenges, rendering them less pleasant and useful for multipurpose fitness activities.

Despite offering a vast array of fitness features, apps such as Strava and Adidas Running still lack certain essential functions, such as step counting, which, according to a 2019 academic study article authored by Harris and his colleagues, may have long-term health benefits. The other half of the 1,297 study participants were not instructed to use pedometers to monitor their steps over the duration of 12 weeks. People who used the pedometer three to four years later were healthier and exercised approximately 30 minutes per week, demonstrating the significance of including a step counter in a fitness application.

Common tracking features found in the majority of fitness applications I've reviewed include monitoring the pulse rate, calories expended, and number of steps taken.

2.3.7. Business Plan

Reviewing comparable existing systems allowed me to consider incorporating a premium version of the app into future plans to provide advanced tracking and analysis, workout plans, personalised nutrition plans, more customisation options, and more advanced graphs and charts to enhance the user experience, especially for experienced athletes who require more advanced features.

This project will not implement a premium version, but it is worth contemplating for future enhancements.

2.4. Sensors

Several additional kinds of sensors can be included in a wearable fitness tracker application, but I've realised that only the heart rate sensor and accelerometer sensor are required.

Galaxy watch 4 was utilised to evaluate each sensor's functionality.

Before adding sensors to your application, the official Android developer website recommends identifying which sensors are available on a particular wristwatch.

It was discovered that the tutorial on the Samsung developer page for determining which sensors are available on a particular smartwatch is both straightforward and helpful.

On the Galaxy Watch4, only the accelerometer, gyroscope, pressure sensor, light sensor, magnetic sensor, and heart rate sensor are genuine hardware sensors (PPG). Other sensors are assemblages of hardware sensors (Nasrin, 2021).

2.4.1. Heart Rate Sensor

Numerous of resources were used to assist me learn how heart rate sensors function in wearable Android devices in order to integrate a heart rate sensor into the application.

In the section entitled "accessing sensor data," Packt (2016) provides an excellent guide for constructing reliable heart rate sensors.

In addition to providing information for Android developers, Quesada (2016) provided an exceptional implementation of a heart rate sensor, which helped me learn more about it and how to precisely implement it.

On the official Android developer website, the distinctions between various data latencies, each of which determines the frequency with which your application receives sensor events, are also described in great detail (2022).

The official Android developer website and my own research indicate that the default data delay, SENSOR DELAY NORMAL, has a delay of 200,000 microseconds but consumes less power than other data delays. SENSOR latency FASTEST has zero microseconds of latency, but depletes the battery the quickest.

A longer delay reduces the processor's workload, resulting in less energy consumption (Android Developers, 2022).

SENSOR DELAY NORMAL is the optimal data delay for the heart rate sensor because it conserves energy and increases battery life.

During an activity that permits the user to monitor their heart rate while exercising, the heart rate sensor would be utilised.

2.4.2. Accelerometer

There are numerous methods for incorporating a step counter into an Android fitness application. Either raw data from an accelerometer-type sensor or a step counter or step detector sensor can be utilised to incorporate a step counter into an application.

Using an accelerometer's raw data is more difficult than using a step counter or step detector because an accurate algorithm must be selected to obtain accurate step counts.

In the section entitled "Brief Introduction to Axes," the designers of Fitbits (2022) did an excellent job describing how the accelerometer works and what the x, y, and z axis represent in the accelerometer sensor.

Programmer World(2019) has uploaded an excellent video tutorial for beginners on how to use an accelerometer and a simple algorithm to calculate the number of steps.

The video demonstrated how to determine the number of steps taken using an accelerometer, which was incredibly useful. However, it was discovered that the algorithm utilised by the video to precisely capture the user's movements is not optimal.

Compared to the YouTube video created by Programmer World, a more accurate step counting algorithm was discovered on stack overflow using raw accelerometer data, such as the technique provided by user13432582 (2021), which displayed more accurate steps.

Using a step counter or step detector-type sensor, however, provides a more accurate count of steps taken and is much simpler to use because such sensors are already calibrated. It has been observed that a step counter or step detector is preferable to an accelerometer for counting steps, especially if the wearable device supports a step counter or step detector.

The two YouTube videos provided by Sarthi technology(2020) helped me comprehend the differences between step counter sensors and step detector sensors, as well as how to use them.

Both step counter and step detector sensors are calibrated accelerometers that can measure the number of steps taken, which makes them useful for fitness applications.

Step counter and step detector-type sensors differ considerably in a number of significant areas, including: When the sensor is active and the step detector initiates an event whenever a step is detected, the step counter maintains account of the number of steps the user has taken since their last reboot.

The YouTuber(Code with Bishesh, 2020) provides a comprehensive tutorial and explanation of how to construct a step counter, reset it daily, and store its value in a database.

The step detector sensor has a latency of less than two seconds, whereas the step counter has a latency of up to ten seconds and a higher degree of precision (Android developers, 2022).

2.4.3. Distance Travelled

In a fitness app to evaluate your progress, you must know the distance you've walked, run, or cycled in kilometres or miles.

The distance travelled can be calculated using a general formula that estimates your step length based on your height, multiplies it by the number of steps taken, and converts the result to kilometres or miles.

Gavin (2016) provides an excellent guide and explanation for converting the number of steps to kilometres. My experiments and those of Gavin (2016) indicate that this method accurately determines distance.

In addition, Sustainabilityinfo (2022) offers a comprehensive explanation of how to calculate the distance walked based on the number of steps taken, calories burned, and walking speed.

David (2015) also provided a fantastic method for calculating the distance in kilometres and the calories burned on the fitness.stackexchange website.

George (2013) implemented the Haversine formula for calculating the distance between two locations using latitude and longitude exceptionally well. His implementation was valuable because it included explanations of how the formula operates.

There is a wealth of information on the official Android Developers website regarding how to obtain your location using latitude and longitude.

Using distanceBetween or distanceTo, it is possible to precisely calculate the distance between two coordinate locations on the official Android developer website (2022).

The advantage of calculating distance from steps is that the distance data will remain quite accurate during a variety of indoor and outdoor exercise routines. GPS distance calculations using latitude and longitude are not always accurate, but they are useful for outdoor activities such as running, cycling, and hiking. It is less effective for indoor activities like cycling and other stationary exercises.

2.5. Features I would like to include in the app

Several fitness apps traits were found after comparing and evaluating previous systems. The easy-to-use user interfaces of Strava for smartwatches and Adidas Running will inspire the design of the app. The wristwatch Strava software displays all activities as buttons on the main page.

The Google fir app's user interface was effective, simple, and well-designed for smartphones, and its home, progress, and profile sections were easy to browse and display information. My app's UI should have comparable attributes.

The fitness app will track heart rate, steps, distance, pace, and calories burned, but it will also have a profile page, graph charts, a progress page to store recent activities, and an easy-to-use interface that solves most of the problems of each tested fitness app.

3.Chapter 3 Design

3.1. Methodology

3.1.1. Considerate methodologies

3.1.1.1. Software prototyping model

Software prototyping model is a software development methodology technique in which the protype is built in minimal requirments. The prototype is then tested and modified based on the feedbacks received from stakeholders and end users until a final prototype will have the desire functionalities (Rana, 2021).

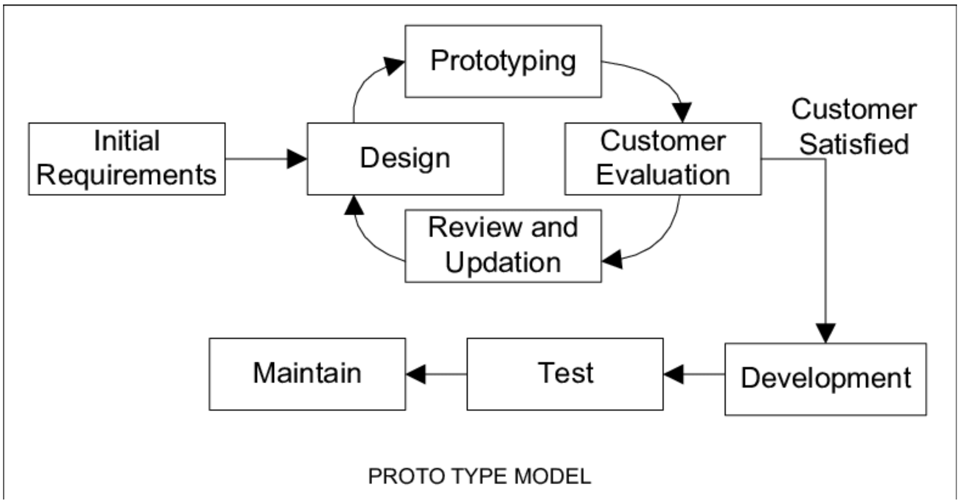


Figure 14 Prototype Model[3]

3.1.2. Selected methodology

3.1.2.1. Reasons for not choosing other types of prototype.

- **Throwaway prototype**:

Due to the little time we have to finish the project, creating a prototype that is subsequently discarded seems like a waste of time and effort compared to utilizing an evolutionary prototype.

- **Incremental prototype**:

Incremental prototype also requires a lot of time to develop multiple prototypes and problems might occur when combining multiples prototypes together.

3.1.3.2. Chosen methodology.

The chosen methodology is an evolutionary prototype.

By identifying potential hazards in advance and taking measurements based on them, evolutionary prototypes reduce the likelihood of failure.

After testing the prototype, stakeholders and business end users can provide feedback on an evolutionary prototype, making it easier for developers to comprehend the requirements.

3.2. Requirments gathering

3.2.1. Project Plan

A project plan is required for software development in order to guarantee project success. This plan divides the project into smaller, more manageable duties.

The project was planned using a Gantt chart, which enables you to schedule a project, organise its duties, and track its progress.

Throughout the duration of the project the Gantt Chart has been revised numerous times.

The initial Gantt chart contained sections for introduction, background research, design, development, testing, and evaluation.

Due to difficulties connecting the devices via Bluetooth and exchanging numerous data between the two, it took me longer than anticipated to finish the first prototype, necessitating a revision of the initial Gantt chart.

Given that the initial Gantt chart was less instructive, the final Gantt is more optimised than the initial one.

A project diary has also been created from the beginning of the project to record a summary of the project's main activities and meetings.

The project log is available in Appendix D.

Appendix A contains additional information regarding the initial Gantt chart.

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter-1 Introduction	Omar			
General Introduction		100%	5/10/22	9/10/22
Porject Scope		100%	7/10/22	9/10/22
Project Definition Form		100%	9/10/22	14/10/22
Project Summary		100%	10/10/22	16/10/22
Structure of Report		100%	12/10/22	16/10/22
Chapter 2 Background	Omar			
Project overview		100%	16/10/22	27/10/22
Smartwatch health benefits		100%	17/10/22	29/10/22
Android Fitess Smartwatches		100%	23/10/22	1/11/22
Similar Systems		100%	3/11/22	22/11/22
Sensors		100%	26/11/22	10/12/22

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter 3 Design	Omar			
Methodology		100%	12/12/22	21/12/22
Term 1 Report		100%	17/12/22	21/12/22
Requirments gathering		100%	24/12/22	28/12/22
Project Plan		100%	5/10/22	
App architecture		100%	30/12/22	13/1/23
Design Choice		100%	18/1/23	1/2/23
Tools and techniques used		100%	2/2/23	8/2/23
Chapter 4 Development	Omar			
Prototype 1 Iteration		100%	23/1/23	8/2/23
Prototype 2 Iteration		100%	8/2/23	22/2/23
Database room		100%	22/2/23	27/2/23
System Development		100%	27/2/23	29/3/23
Final app screenshots		100%	27/3/23	29/3/23

Figure 15 Final Gantt Chart

Chapter 5 Testing	Omar			
White box testing		100%	30/3/23	6/4/23
Black Box testing		100%	30/3/23	6/4/23
creating pre and post questionnaires		100%	6/4/23	8/4/23
User testing		100%	8/4/23	12/4/23
Chapter 6 Evaluation	Omar			
Analyse user testing finding		100%	12/4/23	19/4/23
Features improvments		100%	16/4/23	19/4/23
Conclusion	Omar			
Project Conclusion		100%	20/4/23	23/4/23
Aknowledgement		100%	20/4/23	23/4/23
Statement of originality		100%	20/4/23	23/4/23
Final Report	Omar			
Project Demo		0%	24/4/23	27/4/23
Final Year Report		100%	5/10/22	24/4/23

Figure 16 Final Gantt Chart

The final Gantt chart contains seven phases as opposed to six: introduction, background research, design, development, testing, evaluation, and conclusion.

Appendix A provides additional information regarding the final Gantt chart and its differences from the initial Gantt chart.

3.2.2. Final Software Requirments

Project scope

In the third and final iteration of the prototype, users will be able to initiate an activity, such as walking or running, via the wristwatch app; the activity will then be sent back to the phone app and displayed on the progress page.

The homepage will also feature relevant NHS recommendations and graphs in addition to the user's most recent activity.

Description

In the final phase of system development, the wristwatch app will be designed and completed, walking and running will be functional, the activity will be sent to the smartphone app's progress page, and the user, walking activity, and running data will be stored in the database.

In addition, it will be necessary to design a smartphone home page that displays the user's progress towards the recommended daily step objective, a pie chart, an instruction manual, and relevant NHS recommendations.

Features

Functional Requirments

- The user must be able to submit their information from the profile page.

- The system must be able to transmit multiple data between the phone and watch app.

- The user must have a choice between walking and running.

- A walking and running activity that collects data from user sensors such as heart rate, step count, calories burned, cadence, and distance must be implemented.

- Each exercise activity's design in the smartwatch must be completed.

- The data displayed during exercise must be accurate.

- The Running and Walking activity data must be transmitted to the smartphone's progress page and preserved in the database.

- The progress page must be user-friendly and contain information about completed activities.

- The smartphone app's home page must also display the most recent activity completed, as well as the user's daily steps gaol progress as specified on their profile page.

- The app's main page must include a recommendation from the NHS.

- A pie chart must be incorporated to display the user's progress on each phase.

Out of Scope

• The application will lack an authentication system.

• The system's activities will be limited to walking and sprinting.

• The wear application will lack a database.

• The wear application cannot be used independently.

• The steps will not be tracked when not using the app's running and walking in-app.

Non Functional Requirments

1. Safety and security:
   a. The system should show an error message when user pressed apply without providing the user details in the profile page.
   b.
2. Performance requirments:
   a. The system should allow user to navigate from one page to another with a single click.
   b. The button presses in the app must be responsive (i.e. some action must be shown within half a second).
3. Reliability:
   a. The apps must be built in a way that future instructions can be easily added.

Application Interface

Smartphone app:

- Home screen

- Progress screen
- Profile screen
- **Smartwatch app:**
- Main menu screen
- Walking screen
- Result Activity screen
- Running screen
- Result running activity screen

3.3. App Architecture

The logic tier, database tier, and presentation tier are the three levels that comprise the smartphone application's architecture design.

The logic layer examines the logic of the application, as depicted in the UML diagram's high-class component. As demonstrated in the database model section, the database component evaluates how user data and exercise-related actions are recorded in the database.

The presentation layer displays the application's storyboard and evaluates how users interact with it.

Due to the lack of a database, the wristwatch application consists of two layers: logic and representation.

3.3.1. Database Model

The database used to store user, running, and walking activity data is Room database, which provides an abstraction layer over SQLite to enable fluent database access while leveraging the full potential of SQLite(Rawat, A. ,2019).

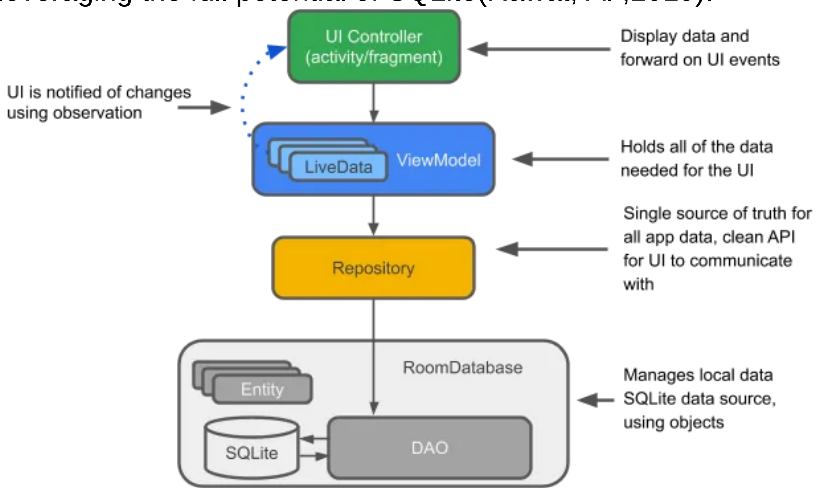


Figure 17 Database Room Architecture

Relational Model

1. User-WalkingActivity

A user can have many walking activities as the user can do the walking activities multiple times ,therefore user-WalkingActivity is a one to many relationship .

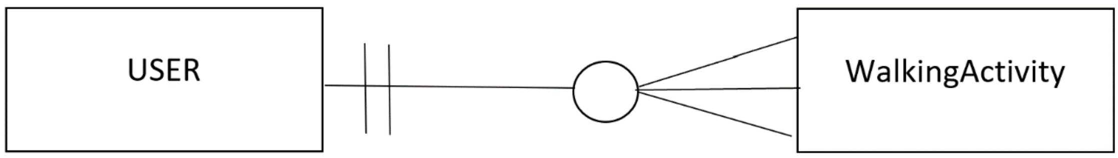


Figure 18 relation between user and walkingActivity table

2. User-RunningActivity

A user can have many running activities as the user can do the running activities multiple times ,therefore user-RunningActivity is a one to many relationship.

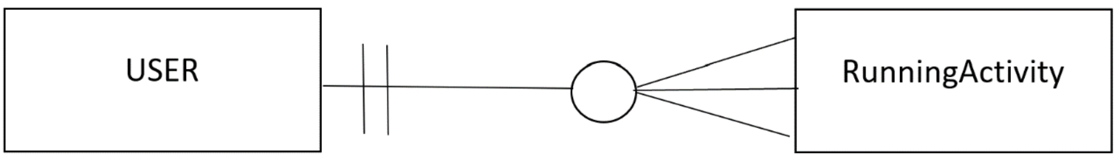


Figure 19 relation between user and runningActvity table

ERD DIAGRAM

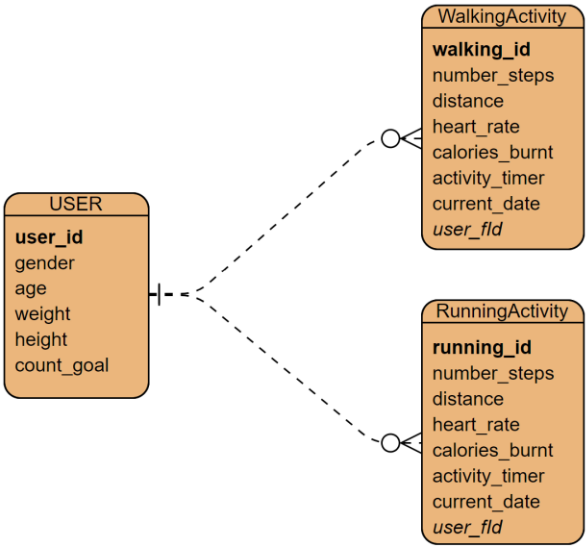


Figure 20 ER Diagram

3.3.2. High level Use case Diagram for the smartphone fitness app

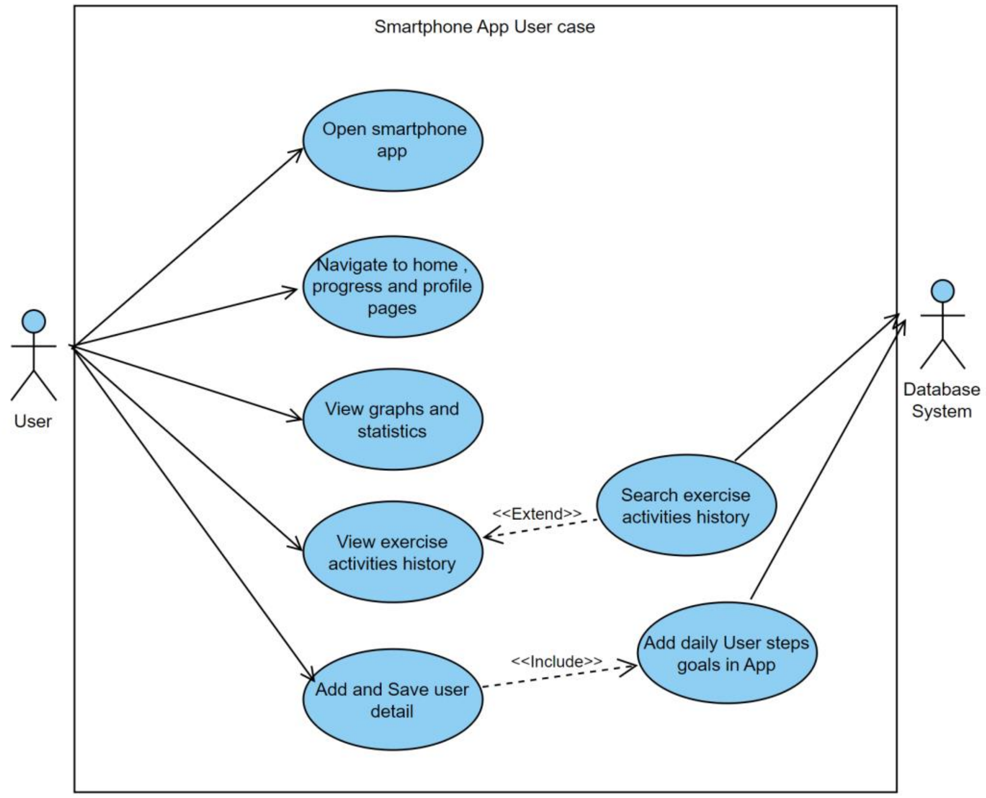


Figure 21 Smartphone use case

<u>High level Description of high level use case diagram for the smartphone app</u>

Use Case	Smartphone fitness app
Actor	**<u>Primary actor:</u>** User **<u>Secondary actor:</u>** Database System
Description	This use case describe how the smartphone app is utilise by the user for the first time .
Detailed Description	User: The user can access the smartphone application's home, progress, and profile sections. On the progress page, the user can also view a graph and a history of their workout activities. The user can also add and save user information on the profile tab. Database system: In addition to storing and adding user data and daily app step counts to a table, the database will also save and retain information on exercise activities.
Basic Path	1. Actor open the App 2. Go to profile page to enter their detail 3. User details are then stored in the database 4. Start activity in the watch app

	5. View user completed activities in progress page 6. Search Activities history in the progress page 7. View graphs in the home page
Pre-Condition	The Actor must Bluetooth connect the phone to the watch in order to run and transfer user information to the watch app.

Table 2 Use case diagram smartphone

3.3.3. High level Use case Diagram for the smartwatch fitness app

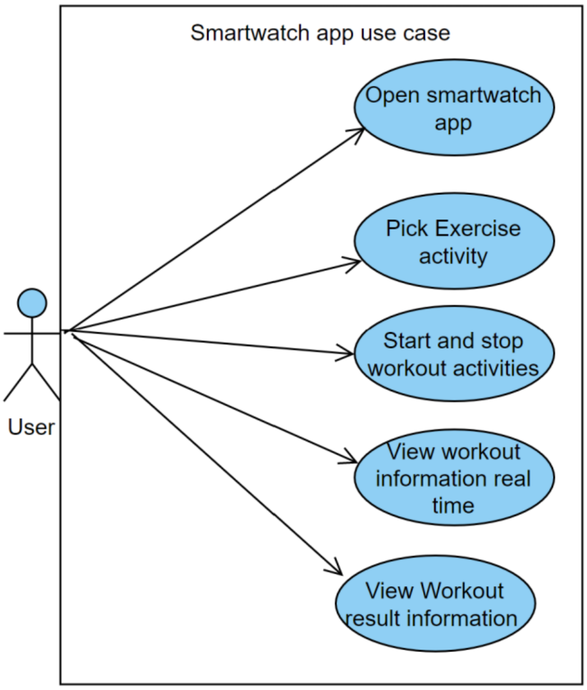


Figure 22 Smartwatch UserCase

<u>High level Description of high level use case diagram for the smartwatch app</u>

Use Case	Smartwatch fitness app
Actor	User
Description	This use case describe how it is utilise by the user .
Detailed Description	User: The user can select from a list of exercise options on the first page. After selecting an activity, the user can initiate and end that activity. In addition, the user can observe useful real-time data such as heart rate, timer, pace, steps, distance, and calories burned.

	After clicking the stop icon, the user can examine the exercise results.

Table 3 user case Diagram smartwatch

3.3.4. Sequence Diagram

Sequence Diagram for the ThirdActivity fragment onCreateView method in the smartphone app

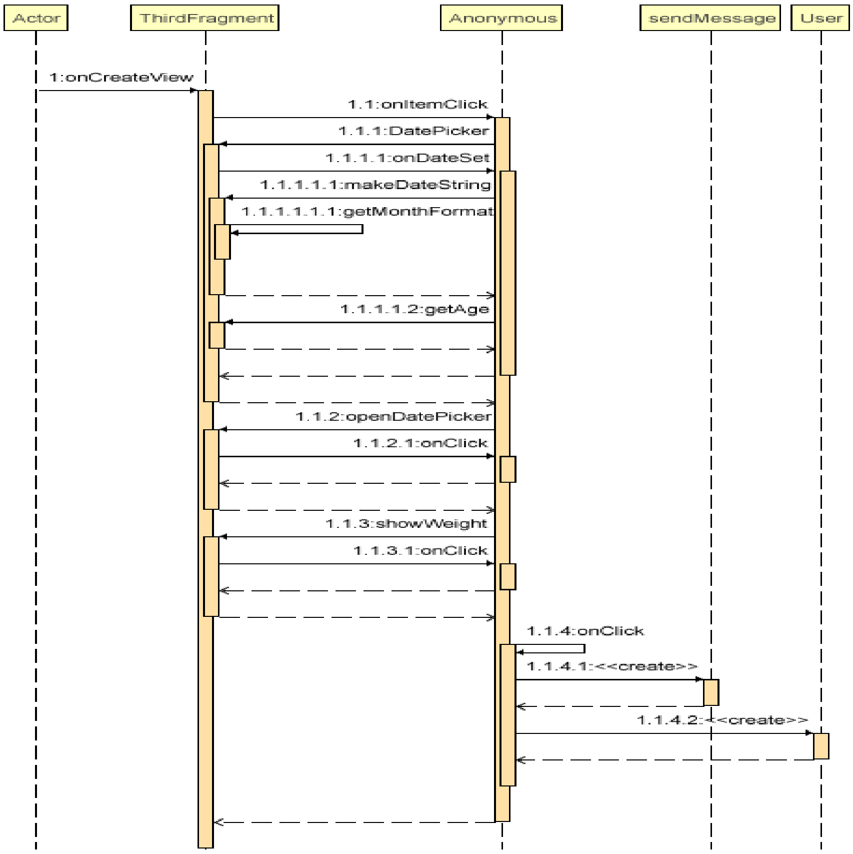


Figure 23 Sequence Diagram ThirdActvity on method onCreateView

Sequence Diagram for the MainActivity onCreate method in the smartwatch app

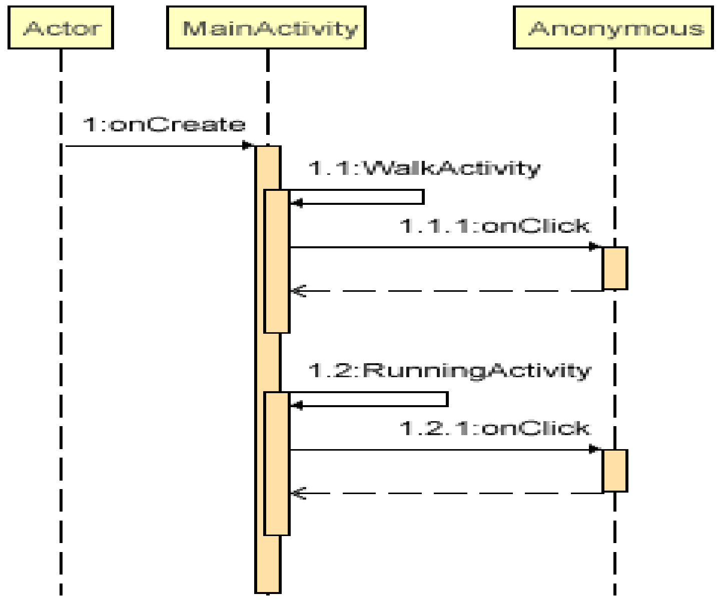


Figure 24 Sequence Diagram onCreate

3.3.5. High level of Class Diagram

Figure 25 UML High Level class Diagram

3.3.6. Storyboard

Storyboard smartphone app

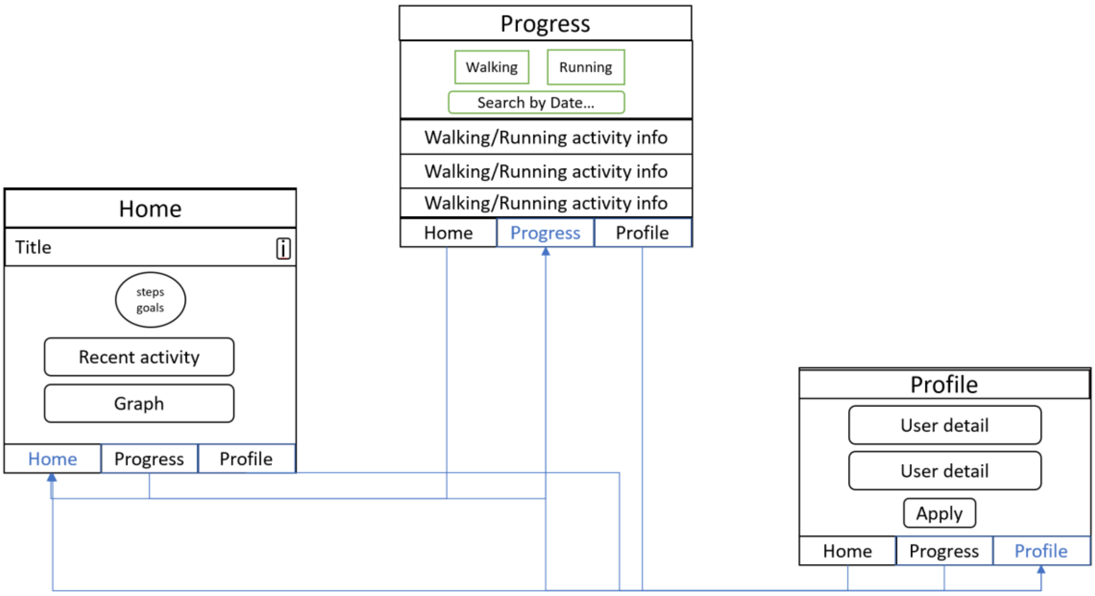


Figure 26 Storyboard smartphone app

Storyboard smartwatch app

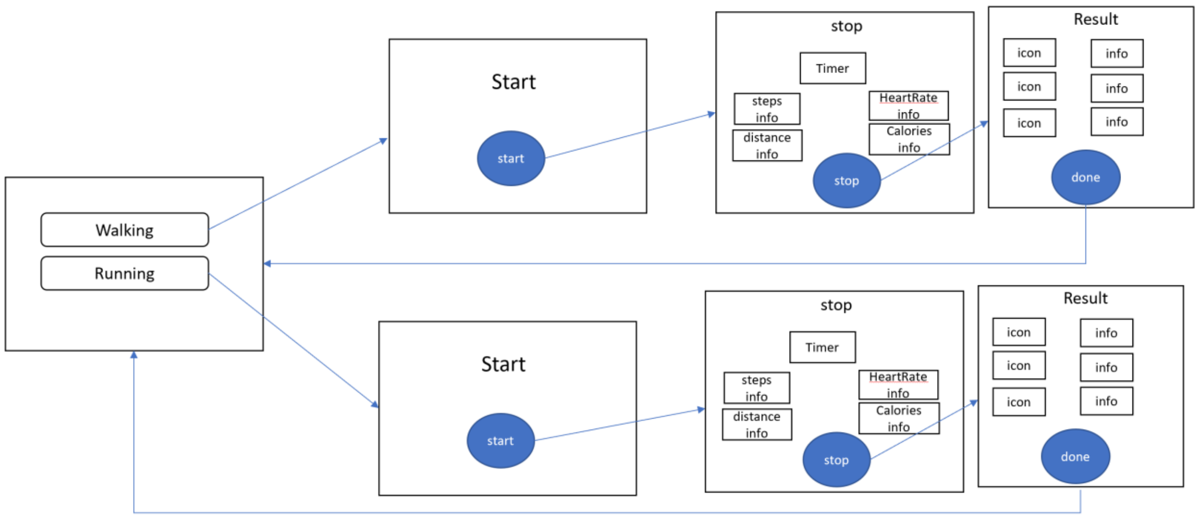


Figure 27 Storyboard smartwatch app

3.3.7. Activity Diagram

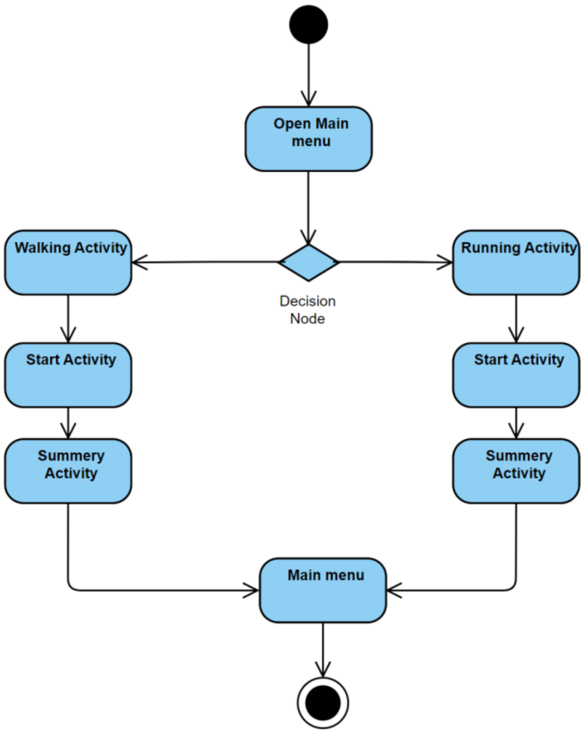


Figure 28 Activity Diagram watch app

3.4. Design Choice

A few existing systems were a source of inspiration for the design of my own fitness app throughout the background research phases.

Phone App

Google Fit was the app that served as my design model for the phone app.

Figure 29 Navigation system

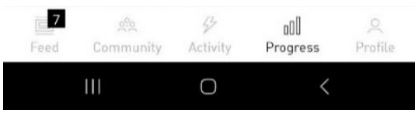


Figure 30 Adidas Navigation system

Figure 31 Google Fit navigation system

The Google Fit app and the Adidas running app served as inspiration for the app's navigation mechanism since they both offered a straightforward, easy-to-use interface.

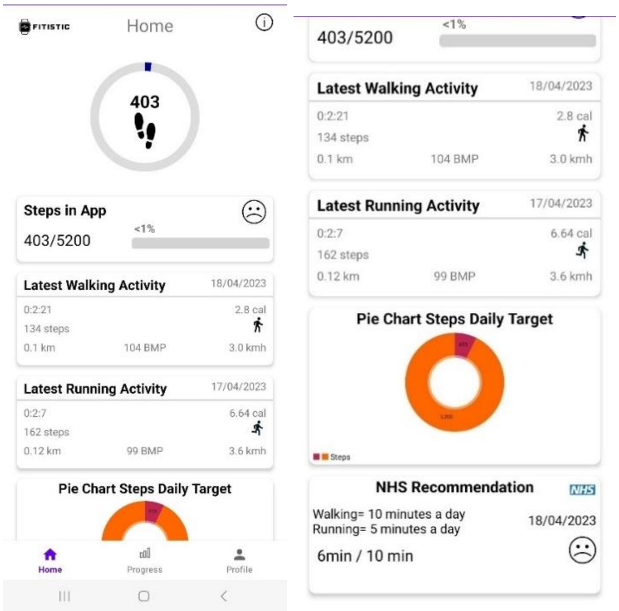


Figure 32 Home Screen

The home interface was designed with simplicity in mind, and functions as a summary of the user's information. For example, the GoogleFit app's main interface did not include the most recent activity information or a pie chart.

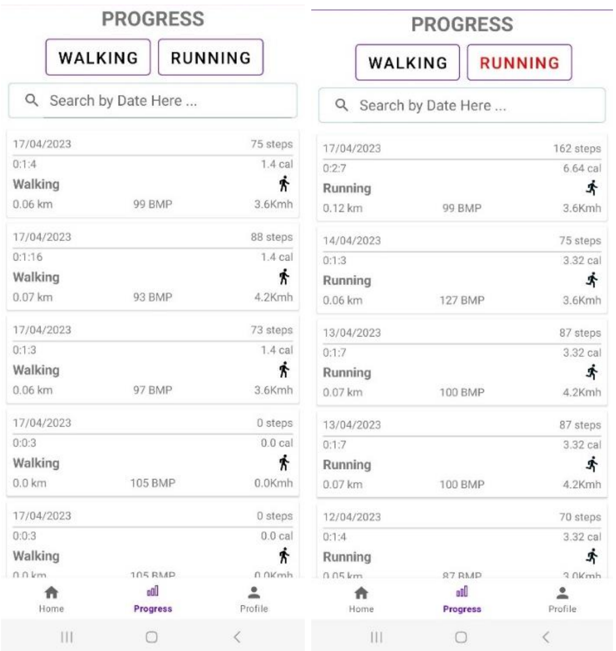


Figure 33 The Progress Page

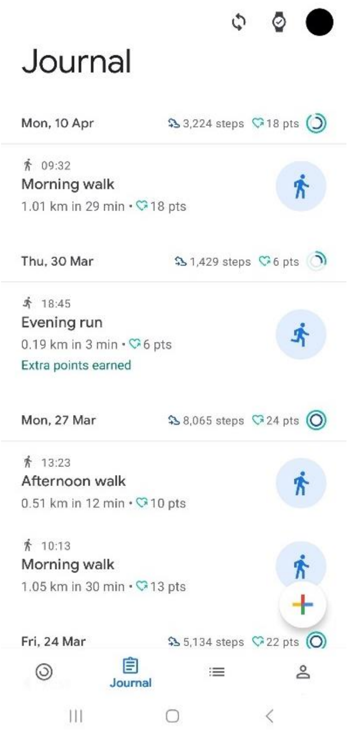
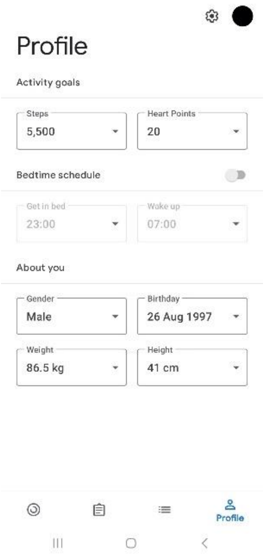


Figure 34 Google Fit Journal screen

The Google Fit journal screen served as inspiration for the progress screen, but significant changes were made to improve the user experience, including the addition of a search bar to look up activities completed by a specific date and the ability to distinguish walking and running activities by pressing a button.



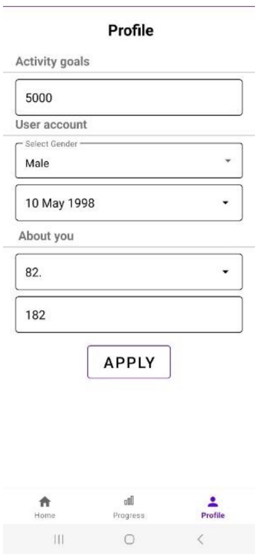


Figure 35 Google Fit profile screen *Figure 36 profile screen*

The Google Fit profile screen served as another source of inspiration for the profile screen due to its simple design that doesn't require the user to devote much time to filling out the boxes.

Watch App

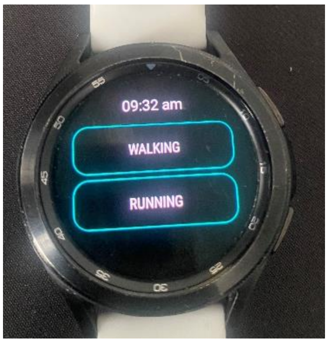


Figure 37 Main menu screen

Figure 38 Strava main menu

The home interface was influenced by the Strava primary menu screen, as shown in figure 38 because it has a simple and intuitive design.

Figure 39 Start screen activity

Figure 40 Activity screen

Figure 41 Adidas activity screen

Figure 42 Adidas result activity

The start screen for any activity was designed to be uncomplicated and straightforward; it was designed after the start screen of the adidas running app.

Although the Adidas Running app was also a source of inspiration for the Activity screen's design, the Activity screen contains more pertinent information.

Figure 43 Result screen

The Adidas running app served as a major inspiration for the result screen as it provide a clear, concise summary of the activity.

3.5. Modelling tools

Visual Paradigm Online

I created the ERD diagram and the use cases for both the smartphone app and the smartwatch app using the free diagramming software Visual Paradigm Online. This utility enables the rapid creation of an extensive variety of diagrams.

Microsoft PowerPoint

Microsoft Visio is a presentation application which I used it to draw the relation model and the storyboard for both the smartphone app and smartwatch app.

3.5.1. Tools used to develop the prototype

Android Studio

Android applications are developed using the IDE (integrated development environment) Android Studio. You create applications with Java or Kotlin and an IntelliJ-based IDE.

Since I had prior experience with Java and Kotlin is an entirely foreign language to me, both the final application and its prototype were constructed using Android Studio and were written in Java.

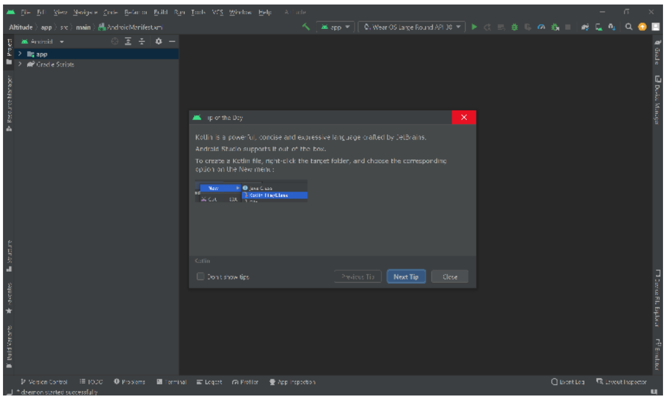


Figure 44 Android Studio

4. Chapter 4 System development

4.1. App development

An overview of some key considerations taken into account throughout the app development stage is provided.

4.1.1. Object Oriented programming

When implementing the system using java android studio, classes, inheritance, interfaces, and packages were considered and included in order to optimise and adhere to best practises.

4.1.2. Extending classes

Classes were expanded to include fragments for the mobile application's home, progress, and profile displays.

Several additional Android classes and interfaces, such as the Dao database interface, were extended or implemented.

Inner classes were utilised whenever practicable to improve encapsulation, logical classification, and legibility.

4.1.3. Connecting phone and watch via Bluetooth

When connecting a physical phone and watch via Bluetooth, it was required to install the wear OS app, connect the watch to the phone app using the app, and then execute the applications using the terminal in android studio.

```
//create a localhost channel

PS C: \Users\ Omar\ Downloads\ platform - tools_r34 .0 .0 - windows\ platform - tools > . /
adb forward tcp: 4444 localabstract: /adb-hub

 4444

//connect the two devices via bluethooth

 PS C: \Users\ Omar\ Downloads\ platform - tools_r34 .0 .0 - windows\ platform - tools > . /
adb connect localhost: 4444

 connected to localhost: 4444
```

Figure 45 Terminal connecting phone to the watch via Bluetooth

As shown in Figure 45, the platform-tools required adb to establish a Bluetooth localhost channel between two devices.

4.1.4. Multithreading

Separate threads were created as using the main thread to transfer multiple data between the smartphone and wristwatch app could potentially cause the threads to halt.

LocalBroadCastManager and broadcast were used to monitor the activities and respond appropriately in order to transmit multiple bidirectional data streams.

Appendix B contains additional information and screenshots regarding Multithreading.

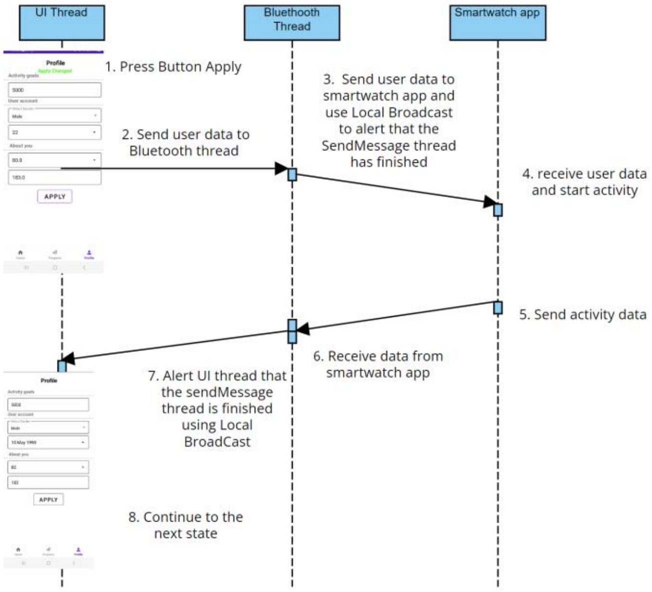


Figure 46 Multithreads demonstration

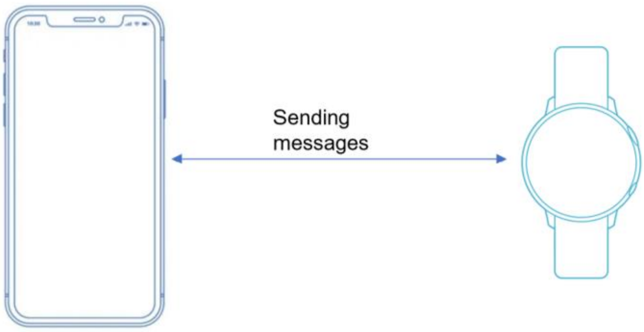


Figure 47 Sending messages

4.1.5. Transferring Data between Activities in the same app

In Android, there are several methods for exchanging data between two activities, with intents being the most common. With an intent, data is bundled as key-value pairs that are retrievable in the receiving activity by using the key to obtain the value. Similarly, another activity can be initiated with intent.

In the wearable app, I used intent to transmit running and walking activity data from the ResultRunningActivity, ResultActivity class to the MainActivity class in addition to launching a second activity. In addition, SharedPreference was used to transmit data between multiple activities, storing fundamental data as key-value pairs and enabling key-based data extraction.

Appendix B contains additional information and screenshots regarding How I used SharedPreference.

```
Intent intent1 = new Intent(getApplicationContext(), MainActivity.class);
intent1.putExtra("hours", hours);
intent1.putExtra("minutes", minutes);
intent1.putExtra("seconds", seconds);
intent1.putExtra("heartRate", heartRate);
intent1.putExtra("stepDetector", stepDetector);
intent1.putExtra("distance", distance);
intent1.putExtra("calories", calories);
intent1.putExtra("pace", pace);
intent1.putExtra("time", time);
intent1.putExtra("current_date", currentDate);
startActivity(intent1);
```

```
Intent intent = getIntent();
int minutes = intent.getIntExtra("minutes", 0);
int hours = intent.getIntExtra("hours", 0);
int seconds = intent.getIntExtra("seconds", 0);
float heartRate = intent.getFloatExtra("heart_rate", 0);
int stepDetector = intent.getIntExtra("step_detector", 0);
double distance = intent.getDoubleExtra("distance", 0.0);
double calories = intent.getDoubleExtra("calories", 0.0);
double pace = intent.getDoubleExtra("pace", 0.0);
String time = intent.getStringExtra("time");
String currentDate = intent.getStringExtra("current_date");
```

Figure 48 sending and getting walking activity data from ResultActivity class to MainActivity class

4.1.6. Sensors in Wear App

A Sensor Manager Helper class was developed to help in the management of various sensors, but it was also intended to be reusable, as it could be used to acquire sensors for a variety of fitness activities, thereby augmenting the code's reusability.

In the WalkingActivity and RunningActivity classes, the SensorManagerHelper was used to initiate and stop the sensors.

As indicated in the section on preceding research, the "SENSOR_DELAY_NORMAL" was used to conserve battery life when registering the sensors.

Despite having a delay of 200,000 microseconds, the heart rate sensor consumes less energy than other data delays.

Appendix B includes additional information about the sensors.

4.1.7. Formulas

There were utilised formulas for calculating calories burned, distance travelled, and average pulse rate.

The average heart rate was calculated using a relatively simple formula: the sum of all heart rates divided by the total number of heart rates.

Several methods were available for calculating the travelled distance, one of which involved combining latitude and longitude with the distanceTo or distance function.

However, testing revealed that it was not as precise as anticipated, so a formula was developed using the user strip and number of steps to calculate a distance that was marginally more accurate.

Despite this, this formula is not entirely accurate.

For future enhancements, I would like to include a GPS map system with more accurate results and a more reliable formula for calculating the distance travelled.

When calculating calories expended, three formulas were considered: the BMR formula, the weight and metabolic rate formula, and the average heart rate formula.

I found the most accurate formula to be the one that utilised weight and mass.

I would like to develop a more precise method for calculating the calories burned.

Screenshots of the formulations are found in Appendix B.

4.1.8. Encouraging users to exercise

On a user's profile screen, they can submit their daily step goals. Numerous research studies discussed in the introduction and background research demonstrated that setting objectives motivates users to exercise.

The incorporation of multiple emoji face modes on the homepage was also meant to encourage users to exercise, with the melancholy emoji face remaining until the user met their daily goals and walked for 10 minutes, as recommended by the NHS.

Appendix B includes additional information about how I encouraged users to exercise.

4.1.9. Prototypes Iteration

There were two prototype iterations prior to the development of the final system.

Since the methodology used was an evolutionary prototype, the prototypes were not discarded; rather, they were refined based on supervisor feedback until the final system was developed.

The first and second prototypes were required for the system's fundamental structure, such as transmitting multiple data between the phone and watch or initiating an exercise activity from the watch and storing the data in a database.

4.2. Final App Screenshot

Phone App

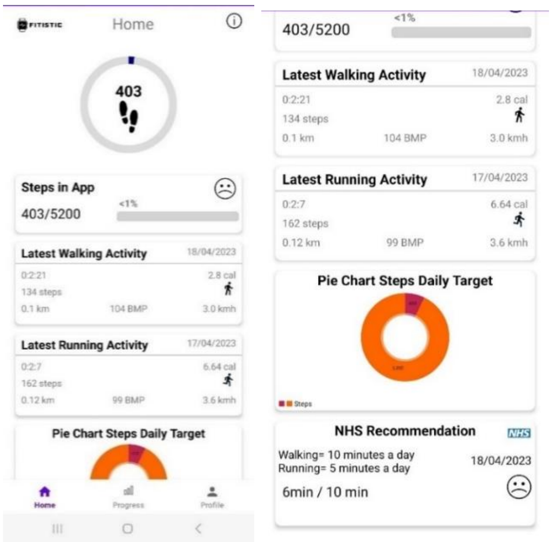


Figure 49 home screen

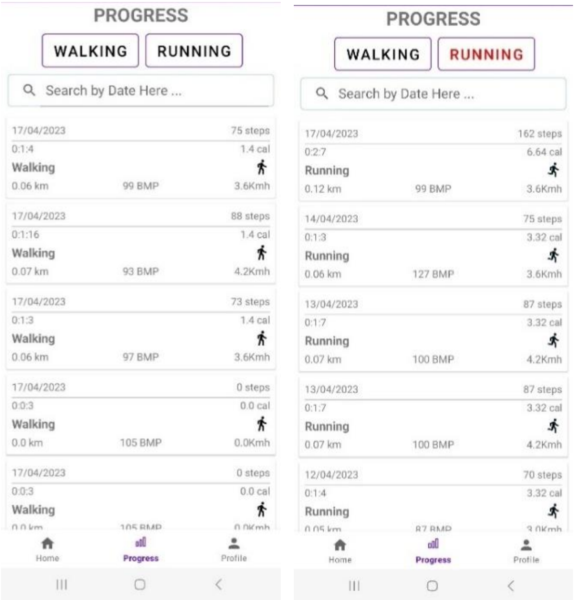


Figure 50 Progress screen

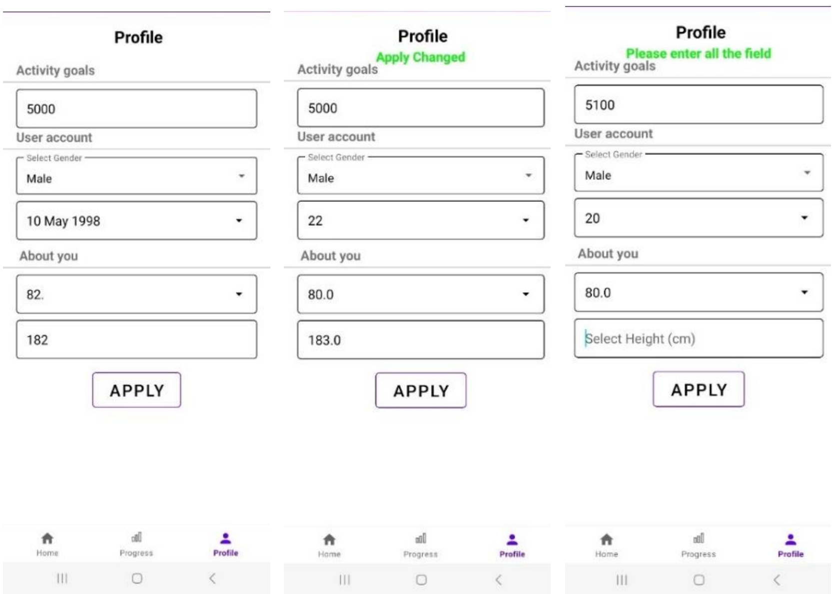


Figure 51 Profile page

Watch App

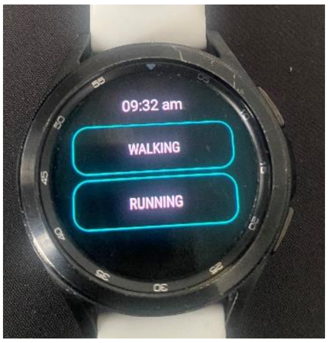


Figure 52 home screen

Figure 53 start screen

Figure 56 Activity screen

Figure 54 result activity

5. Chapter 5 Testing

5.1. System Testing

Unit testing, white box and black box testing, and user acceptance testing are performed on the system throughout the development of both applications.

During the course of their development, the first two prototypes were also tested.

During the phase of design and development, a testing plan was developed and used to evaluate the entire system. The test results are available in Appendix D.

User Testing was also performed to obtain feedback from potential app users.

5.2. System Evaluation

There were also two types of testing with actual adult users, one with potential users (participants) and the other with facilitators (experts).The materials can be located in Appendix C.

5.2.1. Aim of testing

Participant role (non-expert)

The evaluation has two objectives: to conduct real-world testing of the system from the user's perspective to guarantee any future improvements and to ensure that the system provided accurate information in the watch app, as well as to collect feedbacks about the app.

Facilitator role(expert)

The purpose of evaluating the facilitator is similar to that of evaluating the participants; therefore, the evaluation should focus on the system's usability and the app's accuracy, but with the expert in mind.

5.2.2. Participants

Participant role

Ten individuals with no prior programming experience were evaluated for roughly forty minutes. A close relative recruited them, who then solicited the participation of others.

Except for the third day, when four participants were examined, each day three participants were examined.

Facilitator role

Five facilitators were selected to evaluate the system.

Facilitators were tested on the same day.

All of the facilitators have extensive programming knowledge and are in their placement and final year of computer science studies at university.

5.2.3. Tools Used

Participant role

A Samsung galaxy watch 4 and a Samsung galaxy A71 were used to assess the participants, along with a stopwatch to time the duration of the session.

A pre and post questionnaire was also used to collect participant feedback after the app was evaluated.

Facilitator role

In the facilitator session, the same tools were utilised, but a distinct post questionnaire was used to collect expert feedback.

5.2.4. Testing procedure

Participant role

Participants were able to test the watch's walking and running functions, as well as interact with the mobile application.

The session was divided into five parts:

- Welcoming the participants
- Outlining the purpose of the session
- Complete pre-questionnaire
- Participants test the phone app and walk and run while being observed while wearing the watch.
- Complete the post-questionnaire

Facilitator role

The facilitator had the opportunity to evaluate and interact with the system.

The only difference was that facilitator participants verified the app's accuracy, looked for flaws, and evaluated the system's functionality.

5.2.5. Problems

Over the course of the three days that the test was administered, the same individual oversaw both sessions and observed the participants. This could potentially reduce the efficiency of the testing session, as it sometimes took participants longer than 40 minutes to complete the test and questionnaires.

6. Chapter 6 Evaluation

6.1. Finding

In this section, I will analyse and discuss the finding from the data collected from the questionnaires to evaluate the system and discuss about the future improvements.

The data was collected from the google forms and processed with spreadsheets.

6.1.1.1. Summary

The usability test was conducted within an open controlled environment. A single individual served the ethics' committee to ensure participants' safety and compliance with the regulations.

The aim of this test was to perform a formative usability evaluation of the design, highlight the design's strengths and possible flaws, and provide recommendations for improvements. The test was performed to 15 participants ,each session lasted approximately forty minutes.

6.1.2. Pre-questionnaire

To commence the usability test, we dispensed a pre-questionnaire, designed through Google Forms, to gather basic data about the user experience with fitness apps.

This questionnaire consisted of 9 questions, which were answered by the participants on the provided computer, and we collected 15 responses. Closed questions(multiple choice) were mostly included to obtain quantitative data.

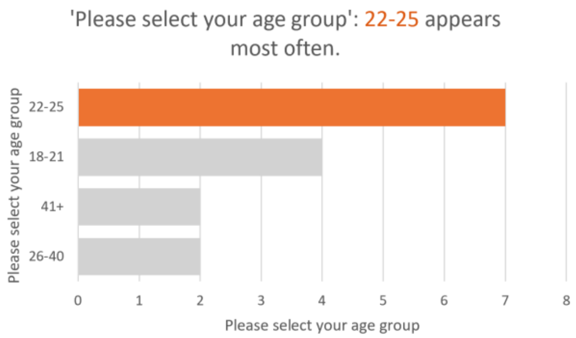


Figure 55 Age group of 15 participants

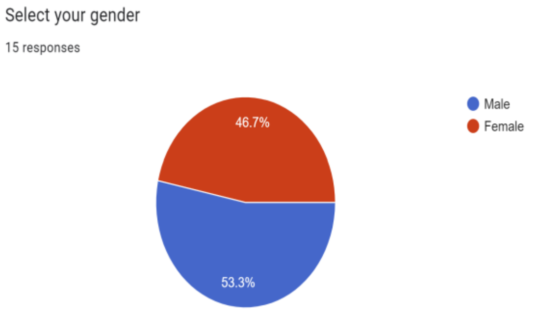


Figure 56 Participants gender

Figures 54 and 55 indicate that 7 of 15 participants, or approximately 46.7%, were between the ages of 22 and 25 and approximately 53% were male.

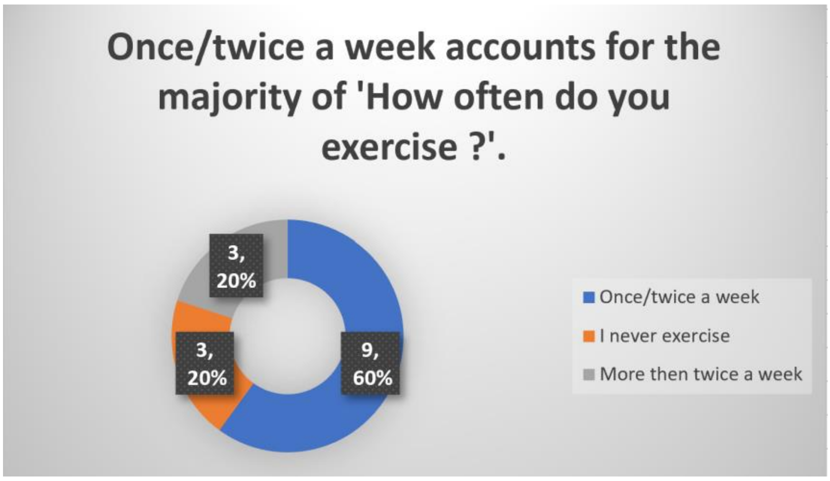


Figure 57 how often do participants exercise

According to data collected from the pre-questionnaire, individuals between the ages of 22 and 25 are most likely to exercise once or twice per week (4 out of 9 participants, or 60% of the responses).

71.43% of participants between the ages of 22 and 25 are also prone to exercise to maintain fitness and health, accounting for 33.33 % of all responses.

According to the collected data, 66.6% of participants, or 10 out of 15, want to use the fitness app to remain active and healthy.

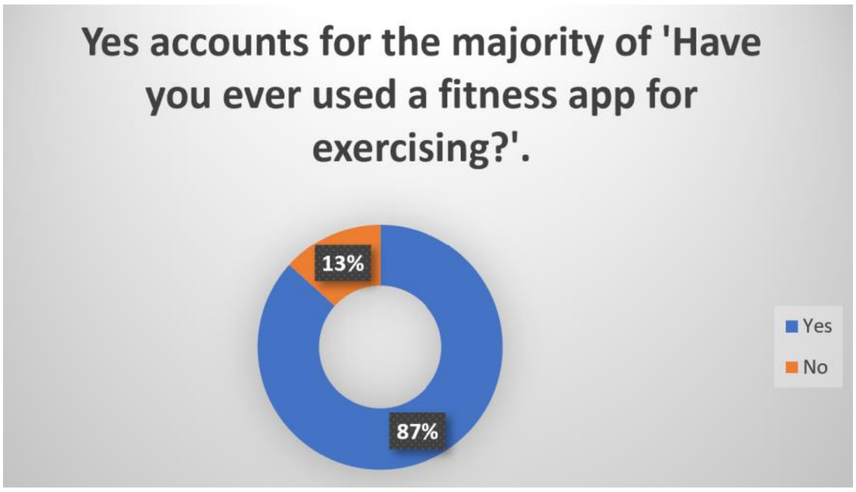


Figure 58 the percentage of people that used a fitness app

87% of participants have previously used a fitness app for exercise, and 53.8% are currently using one.

Five of fifteen participants reported exercising with Google Fit, followed by Strava with three of fifteen users.

7 of the 15 participants (53.8%) who have previously utilised a fitness app for running.

The majority of participants were 22 to 25-year-old men who exercised once or twice per week to maintain their fitness and health.

It also reveals that the majority of participants have previously used a fitness app and that roughly half of participants are presently using a fitness app for running, with the Google fit app being the most popular.

6.1.3. Post-questionnaire

To finish the usability test, it was provided a post-questionnaire designed through Google Forms to obtain quantitative data, therefore the questionnaire contained mostly closed questions.

To preserve data integrity and avoid duplicate results, questionnaires were constrained to one submittable response.

To analyse the data effectively, combining the responses from the pre-questionnaire and post-questionnaire was necessary.

Likert scales, multiple choice, and short and long answers were used.

6.1.3.1. Participants

The post-questionnaire comprised 15 questions categorised in 5 sections. 15 responses were obtained to help us evaluate the system.

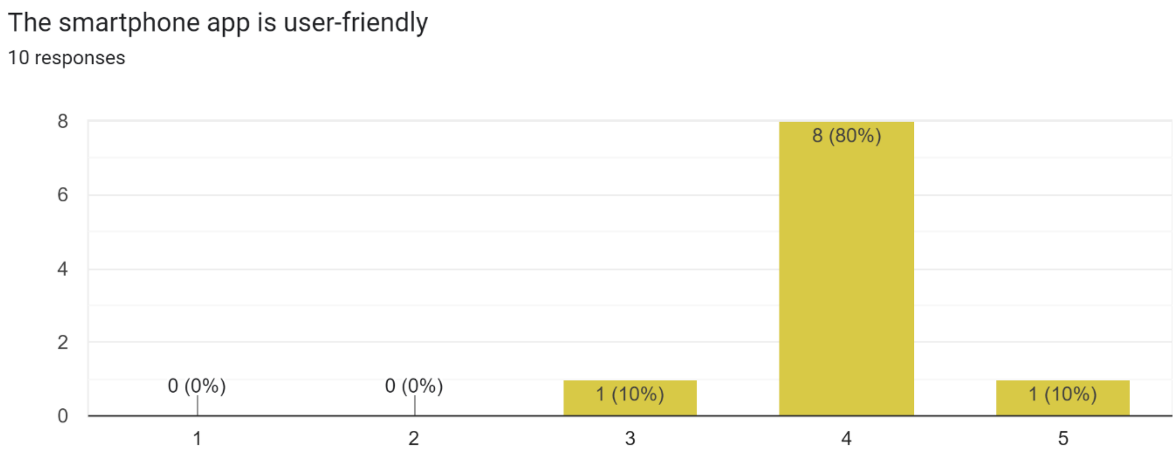


Figure 59 how user-friendly is the smartphone app

Eight out of ten respondents (80%) and seventy percent (70%) indicated that the smartphone app and smartwatch are user-friendly, respectively, based on the collected data.

All respondents agreed that the system does not halt, with seven out of ten indicating that it is simple to initiate an activity using the watch app.

70% of participants believe that the system meets their requirements, and 80% would recommend it to others.

The majority of responses have praised the smartphone application's pie chart, emoji visage, and homepage design.

The majority of respondents disliked the fact that there were only two exercise activities available and the architecture of the progress screen.

In conclusion, the majority of participants provided positive feedback regarding the system's usability, user-friendliness, and overall system, with complaints about the dearth of activities and the architecture of the progress page, indicating that it met user requirements.

6.1.3.2. Facilitator

The post-questionnaire comprised 20 queries categorised in 8 sections. Five responses were obtained to aid in the system evaluation.

According to the data compiled, all participants concur that the smartphone app is easy to use, and 60% consider it to be user-friendly. In contrast, 80% of participants agreed that the watch application is user-friendly, and all participants agreed that it is straightforward to use.

Three out of five respondents identified a defect, with 66.7% indicating that it was task-related and all agreeing that it was not severe.

Sixty percent of facilitators concur that the system meets their needs, and eighty percent would recommend it to others.

Moreover, the majority of participants preferred both the primary screen design of the phone app and the watch app design.

The majority of participants, however, detested that the watch programme did not count steps in the foreground and lacked sufficient exercise activities.

6.1.4. Meeting the requirments

In order to find how many requirments I have met , several unit testing were perform (white box and black box testing).

Step No	Requirments Objective	Result	Did you met the requirement?	Evidence	Appendix evidence
1	Complete the prototype 1	Successful	Yes	The prototype section contains prototype-related evidence.	D
2	Complete the prototype 2	Successful	Yes	The prototype section contains prototype-related evidence.	D
3	The system should allow user to enter their details in the profile page	Successful	Yes	The evidence are found in the testing case 1 in white box testing.	D
4	The system must store walking	Successful	Yes	The evidence are found in	D

	activity data inside the database			the testing case 2 , in the black box testing section.	
5	The system must store user data inside the database	Successful	Yes	The evidence is found in the testing case 3 in the black box section.	D
6	The system must store running activity data inside the database	Successful	Yes	The evidence are found in the testing case 4 , in the black box testing section.	D
7	The system must show recent activities in the progress screen	Successful	Yes	The evidence is found in the testing case 5 in the black box section.	D
8	The system must show the most recent running activity in the progress screen after completing an activity.	Successful	Yes	The evidence is found in the testing case 6 in the black box section.	D
9	The system must show the number of steps taken while exercising in the home screen	Successful	Yes	The evidence is found in the testing case 6 in the black box section.	D
10	The system must show the number of minutes you have walked and run in the NHS recommendation.	Successful	Yes	The evidence is found in the testing case 7 in the black box section	D

Table 4 Meeting requirments

From the results of the testing, it is possible to conclude that all of the initial requirements were satisfied. The test results are available in Appendix D.

In the section of Appendix D titled "Prototype Testing," the two prototype iterations were also evaluated and determined to have been successfully completed.

Usability testing was also performed via black box and white box testing, as well as user testing, and the results indicate that the app's usability was generally well-received by the users who tested it and that it meets the initial requirements.

6.2. Project Management

Throughout the development of the project, I manage it in a variety of ways.

The project required Gantt charts, a project diary, and weekly meetings with the supervisor in order to be managed effectively.

I was able to divide the whole project into subtasks that could be completed within one to three weeks by using Gantt charts. The Gantt chart has been modified throughout the duration of the project in response to obstacles encountered and to refine the project plan.

In addition, a project Diary was created to record a summary of every interaction with the supervisor.

Regular meetings with the supervisor were essential for the project's development.

Regular meetings enabled me to receive client (supervisor) feedback and motivated me to meet the Gantt chart-based deadlines. The prototype has undergone several phases of development and has been refined through regular meetings.

I was able to effectively manage the entire project because of Gantt, the project diary, and regular meetings with the supervisor.

The Appendix Aincludes a Gantt chart and Appendix E contains a project diary.

6.3. Future Improvements

Participants have suggested a number of potential improvements I could make to the two applications based on their post-questionnaire responses.

A common suggestion from the participants was to incorporate more exercise activities to attract a larger audience, and another was to implement a step counter that could calculate steps in the foreground. A further excellent suggestion was to implement a notification system to remind users to exercise, as well as to improve the layout of the profile page.

All of these suggestions are fantastic ways to enhance the application in the future, which I intend to do.

I would also like to enhance the watch application by providing users with the option to use it as a standalone application.

In terms of programming, I'd like to use a location-based GPS with map to calculate travel distance more precisely.

I'd also like to discover a more precise formula for calculating calories expended.

In the future, I would also like to include a warning for users whose resting pulse rate is too low or too high, as this could potentially save a life.

7. Chapter 7 Conclusion

7.1 Project Conclusion

The project has been successfully completed, and the initiative as a whole has been a success.

The primary objectives of the project have been achieved through the creation of a system that allows users to initiate an activity and encourages them to exercise.

The system enables users to set daily step targets before engaging in activities such as walking and running.

The system accomplishes one of its primary goals by providing users with dynamic emoji expressions based on their daily accomplishments.

According to survey results, the user interface of the system was well-received overall, and it appears that the main screen of the phone app was preferred by users over other phone displays.

It was more difficult to implement the system than I had anticipated because I encountered problems throughout the project's development and because it was my first time working on an Android app; however, it was an excellent learning opportunity for adapting to changing conditions and improving my time management.

It was difficult to transmit numerous data between the smartphone app and smartwatch app because there was insufficient information on how to do so.

When accomplishing an activity in the watch app, the user must first open the profile phone app before selecting done.

Additionally, the steps are not tabulated in the periphery; the system displays only the number of steps counted during walking or running.

In addition, the watch application supports two activities: running and walking.

I've learned how to write professional reports, conduct and write professional background research, design a system before the development phase, develop a smartphone and smartwatch android app and make the two apps communicate, run the evaluation and evaluate pre- and post-questionnaires effectively, manage my time and set priorities, and work under pressure.

I have learned about the medical benefits of wearables by perusing compelling research papers and conducting secondary research on the ethical considerations involved in developing a fitness application.

As previously stated, this project enabled me to increase my expertise in Java and Android development. Prior to beginning the project, I lacked experience with android development.

In addition, this project helped me acquire a deeper comprehension of how the database room operates, a concept I had initially struggled to comprehend.

I've learned to consult the Android developer documentation throughout the development process due to the limited resources available when developing Android applications with Java.

If I were to repeat this project, I would have spent more time in the beginning on how to effectively send multiple data between the phone and app and how to connect the phone and watch via Bluetooth in order to run the two apps on android studio, since I initially believed that sending data would have required less time than it did.

I would also spend some time determining how to count your steps in the foreground utilising notification.

In conclusion, the development of the project was a beneficial experience that expanded my understanding of system development.

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Appendices

Appendix A

1. Remain information about the Gantt Chart

Initial Gantt Chart

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter-1 Introductic	Omar			
General Introduction		100%	5/10/22	9/10/22
Porject Scope		100%	7/10/22	9/10/22
Project Definition Form		100%	9/10/22	14/10/22
Motivation		100%	10/10/22	16/10/22
Structure of Report		100%	12/10/22	16/10/22
Chapter 2 Background	Omar			
Development choice		100%	16/10/22	27/10/22
Smartwatch health benefits		100%	17/10/22	23/10/22
Wearable		100%	17/10/22	26/10/22
Similar Systems		100%	28/10/22	16/11/22
Sensors		100%	20/11/22	30/11/22

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter 3 Design	Omar			
Methodology		60%	2/12/22	11/12/22
Term 1 Report		60%	7/12/22	11/12/22
Tools and techniques used		0%	14/12/22	24/12/22
User Requirments		0%	20/12/22	24/12/22
Sequence diagram		0%	25/12/22	31/12/22
Chapter 4 Developme	Omar			
Prototype 1 Iteration		0%	20/1/23	5/2/23
Prototype 2 Iteration		0%	5/2/23	19/2/23
Prototype development		0%	19/2/23	24/2/23
Use case diagrams		0%	24/2/23	5/3/23
Database model		0%	3/3/23	5/3/23
System development		0%	5/3/23	12/3/23

Figure 60 initial Gantt Chart

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter 5 Testing	Omar			
White box testing		0%	12/3/23	19/3/23
Black Box testing		0%	19/3/23	26/3/23
Chapter 6 Evaluation	Omar			
Evaluate featutes inplemented		0%	26/3/23	2/4/23
Project achievment		0%	30/3/23	2/4/23
Drawbacks of the system		0%	2/4/23	9/4/23
Features improvments		0%	2/4/23	9/4/23
Lesson Learnt		0%	2/4/23	9/4/23
Final Report	Omar			
Project Demo		0%	9/4/23	23/4/23
Final Year Report			5/10/22	23/4/23

Figure 61 Initial Gantt Chart

Initially, the entire project was divided into six distinct phases, as shown in Figure 60 and 61.

Final Gantt Chart

TASK	ASSIGNED TO	PROGRESS	START	END
Chapter-1 Introduction	Omar			
General Introduction		100%	5/10/22	9/10/22
Porject Scope		100%	7/10/22	9/10/22
Project Definition Form		100%	9/10/22	14/10/22
Project Summary		100%	10/10/22	16/10/22
Structure of Report		100%	12/10/22	16/10/22
Chapter 2 Background	Omar			
Project overview		100%	16/10/22	27/10/22
Smartwatch health benefits		100%	17/10/22	29/10/22
Android Fitess Smartwatches		100%	23/10/22	1/11/22
Similar Systems		100%	3/11/22	22/11/22
Sensors		100%	26/11/22	10/12/22

Chapter 3 Design	Omar			
Methodology		100%	12/12/22	21/12/22
Term 1 Report		100%	17/12/22	21/12/22
Requirments gathering		100%	24/12/22	28/12/22
Project Plan		100%	5/10/22	23/4/23
App architecture		100%	30/12/22	13/1/23
Design Choice		100%	18/1/23	1/2/23
Tools and techniques used		100%	2/2/23	8/2/23
Chapter 4 Development	Omar			
Prototype 1 Iteration		100%	23/1/23	8/2/23
Prototype 2 Iteration		100%	8/2/23	22/2/23
Database room		100%	22/2/23	27/2/23
System Development		100%	27/2/23	29/3/23
Final app screenshots		100%	27/3/23	29/3/23

Figure 62 Final Gantt Chart

Chapter 5 Testing	Omar			
White box testing		100%	30/3/23	6/4/23
Black Box testing		100%	30/3/23	6/4/23
creating pre and post questionnaires		100%	6/4/23	8/4/23
User testing		100%	8/4/23	12/4/23
Chapter 6 Evaluation	Omar			
Analyse user testing finding		100%	12/4/23	19/4/23
Features improvments		100%	16/4/23	19/4/23
Chapter 7 Conclusion	Omar			
Project Conclusion		100%	20/4/23	23/4/23
Aknowledgement		100%	20/4/23	23/4/23
Statement of originality		100%	20/4/23	23/4/23
Final Report	Omar			
Project Demo		0%	24/4/23	27/4/23
Final Year Report		100%	5/10/22	24/4/23

Figure 63 Final Gantt Chart

As shown in Figures 62 and 63, the complete project was divided into six distinct phases on the final Gantt chart.

The introduction was broken down into tasks that could be completed within a week or two: general introduction, project scope, project definition form, project summary, and report structure.

The objective of the first phase was to provide an informative introduction to the report's and project's subject matter.

The second phase (background research) was divided into five subtasks: project overview, smartwatch health benefits, android fitness smartwatches, and comparable systems and sensors.

A comprehensive literature review of smartwatches, fitness applications, and their sensor capabilities was intended for the second phase.

The third phase (background research) was divided into five subtasks: methodology, term 1 report, requirements gathering, project plan, App architecture, design selection, and tools and techniques utilised.

Planned activities for the third phase included accumulating User requirements, designing prototypes and diagrams, and concluding the term 1 report.

The fourth phase (the development phase) was divided into five subtasks: prototype 1 iteration, prototype 2 iteration, database model, system development, and Final App screenshots.

In addition to implementing the first and second prototypes and developing the final system, the fourth phase was intended to include the creation of diagrams and the presentation of final app screenshots.

The fifth phase (Testing phase) was divided into four subtasks: White Box testing, Black Box testing, the creation of pre- and post-questionnaires, and user testing.

The fifth phase was intended to involve evaluating the system using various techniques and obtaining user feedback.

The sixth phase (Evaluation phase) was divided into two smaller tasks: user testing findings analysis and future enhancements.

The sixth phase was intended to comprise of evaluating the results of the user testing and discussing future enhancements briefly.

The final phase (Conclusion) was divided into three smaller tasks: project conclusion, acknowledgement, and originality student.

Planned for the final phase were a reflective conclusion and the completion of the report.

Comparison between the initial and final Gantt chart

During the design and development phase, the primary Gantt has undergone multiple revisions.

As motivation was also discussed in the project scope section, it was determined to remove the motivation section from the final Gantt chart's introduction phase and substitute it with a project summary. The only difference between the background research and the initial Gantt chart is that a project overview was added to briefly describe to the reader what that section is about.

The design section of the final Gantt chart has been optimised due to the decision to work on tools and requirements at the conclusion of the section, as well as the addition of tasks such as a discussion of the project plan, app architecture, and design decisions.The initial gantt chart's sequence diagram is now incorporated into the application's architecture.

In the development section of the final Gantt chart, some changes were made; the prototype took longer than anticipated because connecting the two devices via Bluetooth and sending multiple data between the two devices proved to be more difficult than anticipated; consequently, the prototype 1 iteration was updated with a longer duration, and the use case diagrams were moved to the design phase.

The Testing section of the Gantt chart has been updated to include user testing as an additional method for testing the application.

The conclusion section of the final Gantt chart was also revised to include the project's accomplishments, setbacks, and lessons learned, while acknowledgments and a statement of originality were discussed at the conclusion of the report.

Appendix B

1. Transferring multiple data between activities

```
//sharedPreference
 sharedPreferences = getSharedPreferences("userData", Context.MODE_PRIVATE);
 //editor
 SharedPreferences.Editor ed = sharedPreferences.edit();
 //check if gender ,height, weight and age values are not null
 if (gender != null && Height != null && Weight != null && Age != null) {
    //store the values in a sharedPreferece
   ed.putString("gender", gender);
   ed.putString("Height", Height);
   ed.putString("Weight", Weight);
   ed.putString("Age", Age);
   ed.commit();
```

Figure 64 storing data inside SharedPreference to transfer data across multiple activities

```
//getting user data from mainActivty
 sh = getSharedPreferences("userData", Context.MODE_PRIVATE);
 //storing the data inside the variables
 gUser = sh.getString("gender", "");
 wUser = sh.getString("Weight", "");
 hUser = sh.getString("Height", "");
 aUser = sh.getString("Age", "");
```

Figure 65 extracting the data saved in the sharedPreference and store them in variables

2. Multi-Thread screenshots

```
class sendMessage extends Thread {
//initialise path and dataMap
  String path;
  DataMap dataMap;
  // Constructor for sending data objects to the data layer
  sendMessage(String p, DataMap data) {
    path = p;
    dataMap = data;
  }
  public void run() {
    // Construct a DataRequest and send over the data layer
    PutDataMapRequest putDMR = PutDataMapRequest.create(path);
    putDMR.getDataMap().putAll(dataMap);
    PutDataRequest request = putDMR.asPutDataRequest();
    DataApi.DataItemResult result = Wearable.DataApi.putDataItem(googleClient,
request).await();
//display successfully sent when the data is sent to the lisntener
    if (result.getStatus().isSuccess()) {
      Log.v("myTag", "DataMap: " + dataMap + " sent successfully to data layer ");
    } else {
      // Log an error
      Log.v("myTag", "ERROR: failed to send DataMap to data layer");
    }
  }
}
```

Figure 66 SendMessage class start a new thread when sending message

3. Sensors in Wear App

To transmit a message, the inner SendMessage class initiates a new thread with two parameters: a path and a dataMap. The path is the path key that identifies where the message originated, while dataMap is used to store messages to be sent.

```
public class ListenerService extends WearableListenerService {
  WEARABLE_DATA_PATH = "/wearable_data";
  @Override
  public void onDataChanged(DataEventBuffer dataEvents) {
    DataMap dataMap;
    for (DataEvent event: dataEvents) {
      Log.v("myTag", "DataMap received on phone: " +
DataMapItem.fromDataItem(event.getDataItem()).getDataMap());
      // Check the data type are equal
      if (event.getType() == DataEvent.TYPE_CHANGED) {
        // get the data path
        String path = event.getDataItem().getUri().getPath();
          //check if the path is equal to the path defined in this class
        if (path.equals(WEARABLE_DATA_PATH)) {
          //store the dataMap
        dataMap = DataMapItem.fromDataItem(event.getDataItem()).getDataMap();
        // Broadcast DataMap contents to wearable activity for display using Intent
        Intent messageIntent = new Intent();
        messageIntent.setAction(Intent.ACTION_SEND);
        messageIntent.putExtra("datamap", dataMap.toBundle());
        LocalBroadcastManager.getInstance(this).sendBroadcast(messageIntent);
```

Figure 67 LocalBroadcast is used in the service class to listen to activities

```
//receiving the message
public class MessageReceiver extends BroadcastReceiver {
 @Override
 public void onReceive(Context context, Intent intent) {
     // using bundle to get the data
     Bundle data = intent.getBundleExtra("dataMap");
     // Display received data in UI
     gender = data.getString("gender");
     Height = data.getString("Height");
     Weight = data.getString("Weight");
     Age = data.getString("Age");
```

Figure 68 Receiving Data in the wear app using Bundle

A class MessageReceiver is creating that extends BroadCastReceiver which received the data once the data is changed by calling the Bundle and storing them into variables.

```
@Override
 public void onSensorChanged(SensorEvent event) {
   //if a heart rate sensor is detected
   if (event.sensor.getType() == Sensor.TYPE_HEART_RATE) {
    //store the heart rate in a variable
     heartRate = "" + (int) event.values[0];
    //show  in the screen the heart rate
     txtRHeartRate.setText("" + heartRate);
     //calculating average heart rate
     if (Float.parseFloat(heartRate) != 0) {
       heartRateSum += Float.parseFloat(heartRate);
       numbersofHeartRate++;
```

Figure 69 getting heart rate sensor data in OnSensorChanged method by implementing SensorEventListener

```
sensorManager.registerListener(this, heartRateSensor, SensorManager.SENSOR_DELAY_NORMAL);
```

Figure 70 registering sensor Heart Rate

```
//step detector sensor
 if (event.sensor.getType() == Sensor.TYPE_STEP_DETECTOR) {
   //store step detector
  stepRDetectorCount = (int)(stepRDetectorCount + event.values[0]);
  show in the screen the step detector every time it is detected
  txtRStepDetector.setText("" + stepRDetectorCount);
```

Figure 71 Step detector sensor was used to also find the calories ,distance travelled and pace

4. Formulas

```
//calculating average heart rate
if (Float.parseFloat(heartRate) != 0) {
  heartRateSum += Float.parseFloat(heartRate);
  numbersofHeartRate++;
```

Figure 72 Calculating average heart rate

```
//calculating the average heart rate
 averageHeartRate = heartRateSum /    numbersofHeartRate;
```

Figure 73 Calculating the average heart rate

```
double strip = 0;
//check if the user is male or female
if (gUser.equals("Male")) {
 // strip calculation for male
  strip = Double.parseDouble(String.valueOf(hUser)) * 0.415;
} else if (gUser.equals("Female")) {
   //strip calculation for female
  strip = Double.parseDouble(String.valueOf(hUser)) * 0.413;
}
//calculating the distance by multiplying the strip to the step detector and divide it by
100000.
distance = Double.parseDouble(String.format("%.2f", (stepRDetectorCount * strip) /
100000));
// show distance in the screen
txtRDistance.setText("" + distance);
```

Figure 74 Calculating distanced travelled

```
//calculating calories burnt using Met and weight of user
caloriesBurnt = minutes * (met * 3.5 * weight) / 200;
 //display calories in the screen
txtRCalories.setText("" + Double.parseDouble(String.format("%.2f", caloriesBurnt)));
//calculating pace
pace = minutes / distance; // speed in minutes per kilometers
pace = 60.0 / pace; //convert the speed in kilometers per hour
```

Figure 75 Calculating calories burnt

5. Encouraging users to exercise

```
//calculating the percentage of the current Steps taken divided by daily goal steps *100
percentageSteps=(result/countGoal)*100;
```

Figure 76 Calculating the percentuage of current steps taken

```
//show state emoji face
If the current Steps are less 20% of the total goal steps
 if (percentageSteps < 20) {
//show sad face emoji
   imgFace.setImageResource(R.drawable.ic_sad_face);
//if it is less then 60% show normal face
 } else if (percentageSteps < 60) {
   imgFace.setImageResource(R.drawable.ic_normal_face);
// if it is bigger then 60% shows happy face
 } else {
   imgFace.setImageResource(R.drawable.ic_smiley_face);
 }
```

Figure 77 Shows face emoji based on achievement

Appendix C

1. Pre-Questionnaire

https://forms.gle/PWMBH2NFcALx1Tw46

Pre Questionnaire.csv

2. Post-Questionnaire Participants

https://forms.gle/RxwQuP3cR1U37NXn9

Fitness App.csv

3. Pre-Questionnaire Facilitators

Pro-Questionnaire.csv

https://forms.gle/Wr6w5TLvygt4BGp68

Appendix D

1. Prototype Testing

1.1. Prototype 1

Project scope

The first version of the prototype will allow user to send data from the smartwatch app to the phone app and vice versa.

Description

The prototype 1 will allow users to a way to establish a communication between the smartphone app and smartwatch app .

The smartphone app must also show a simple navigation system in the smartphone.

Features

Functional Requirments

- You must be able to establish a connection between smartphone app and smartwatch app
- A message connected must be displayed on the smartphone app once the smartwatch app is connected to the phone app.
- A simple navigation system must be implemented into the smartphone app.

Testing results

Step No	Test Objective	Step description	Test Data	Expected Result	Result
1	Send data from watch to phone and vice versa	a. Enter user details b. Press button apply	Data sent Data received	The data is sent successfully from the phone to the watch and vice versa	Success

Table 5 Prototype 1 testing

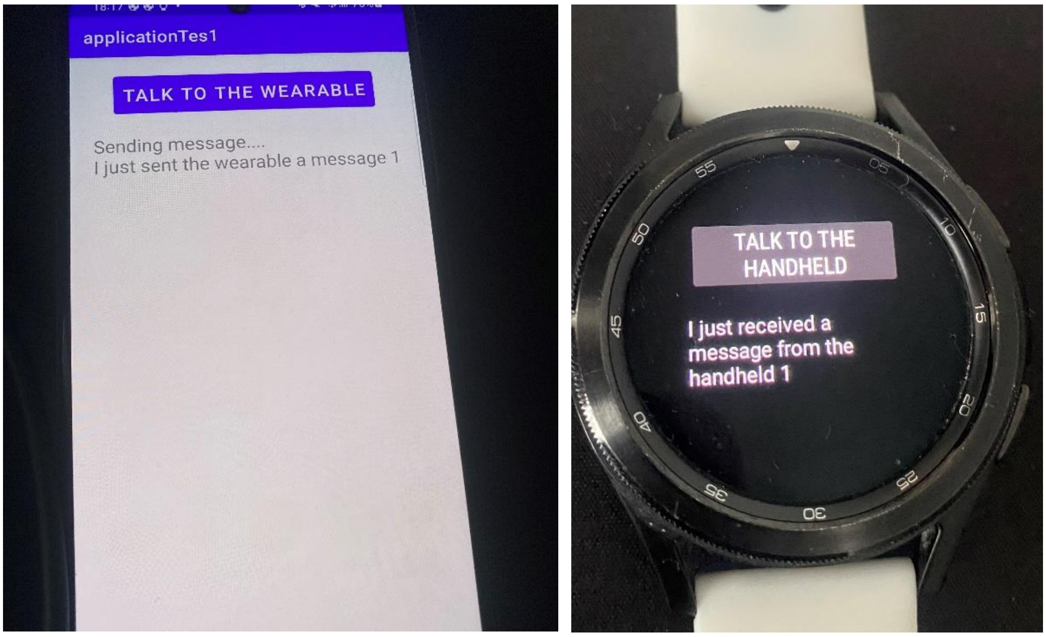


Figure 78 Testing sending data from phone to watch app

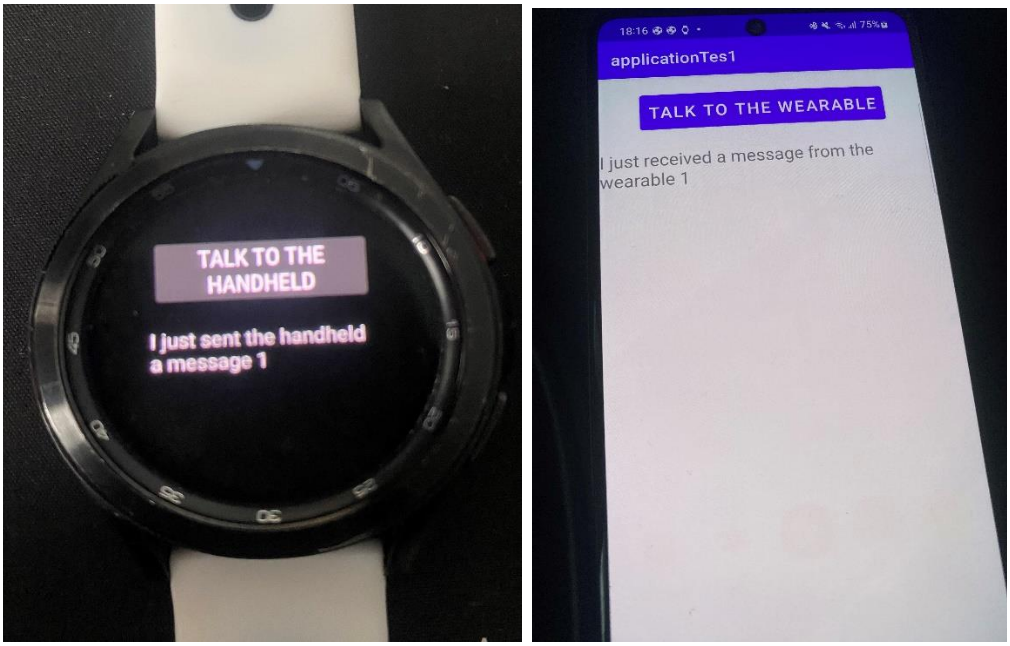


Figure 79 Testing sending data from watch to phone app

1.2. Prototype 2

Project scope

The second version of the prototype will allow user start an activity like walking or running from the smartwatch app and send the activity data back to the phone app in the progress page.

Description

The prototype 2 will allow users to start an activity from the watch phone by pressing a button and the activity will be store in the database and then used in the smartphone app in the progress page.

The profile page in the smartphone app should also be design and should collect the user data which it is send to the database and smartwatch app.

Features

Functional Requirments

- Designing the profile page and collect the user name ,age ,height and weight .
- Have a basic design for the smartwatch app with a button for a walking or running activity
- A walking or Running activity must be implemented which collect some user sensors data such as the heart rate , step counts , calories burnt , pace and distance .
- The collected data from the activity must be send to the smartphone in the progress page and stored in the database.

Non Functional Requirments

a) Reliability:
- The system should set the timer as soon as the user start an activity
- The system should also calculate the calories in real time once the user start an activity.

Testing result

Step No	Test Objective	Step description	Test Data	Expected Result	Result
2	Start activity and send data back to the phone and display it in the progress screen	a. Start activity b. Finish activity	Start activity. Finish activity. Activity information stored in database. Activity information displayed in the progress page.	The activity data is successfully displayed in the progress page and stored in the database after completing an activity	Success

Table 6 Prototype 2 testing

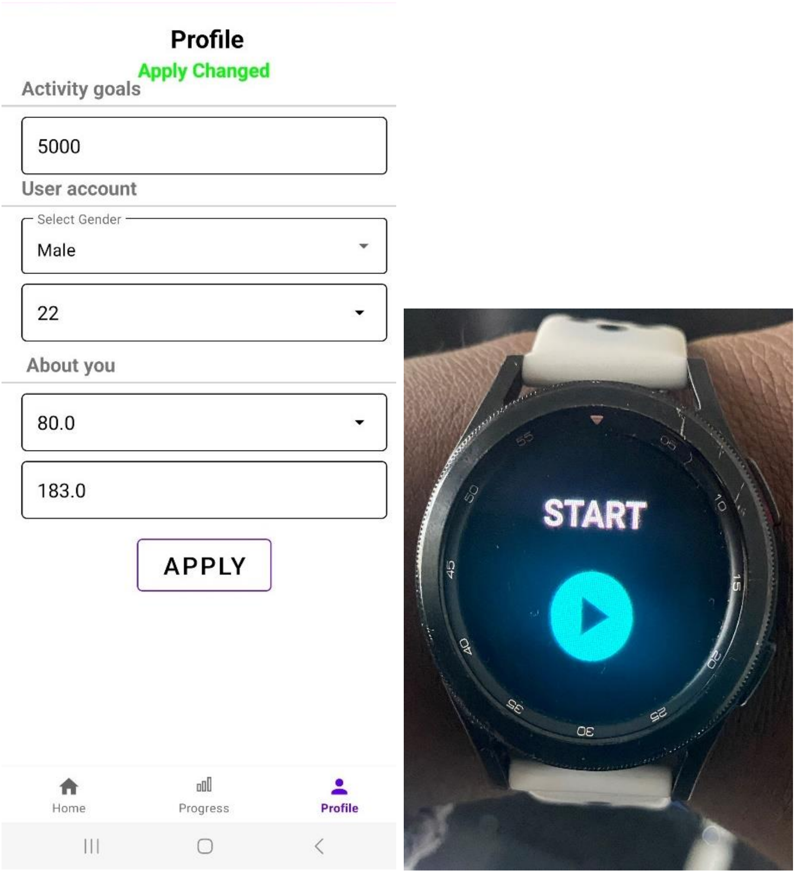
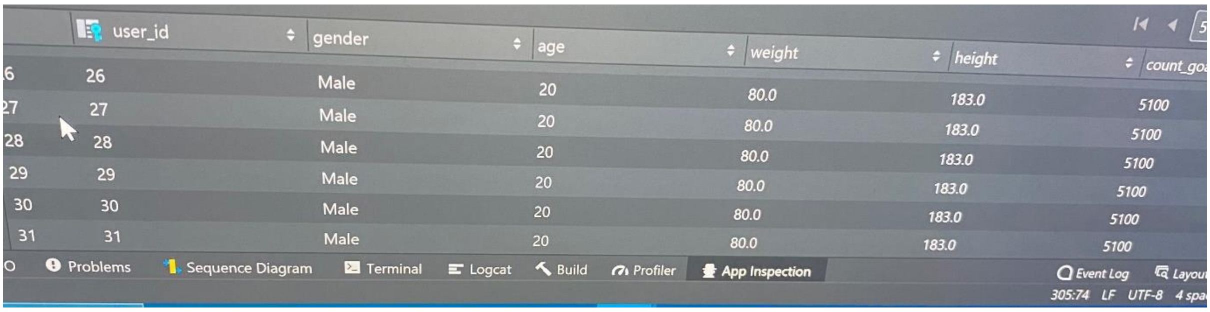


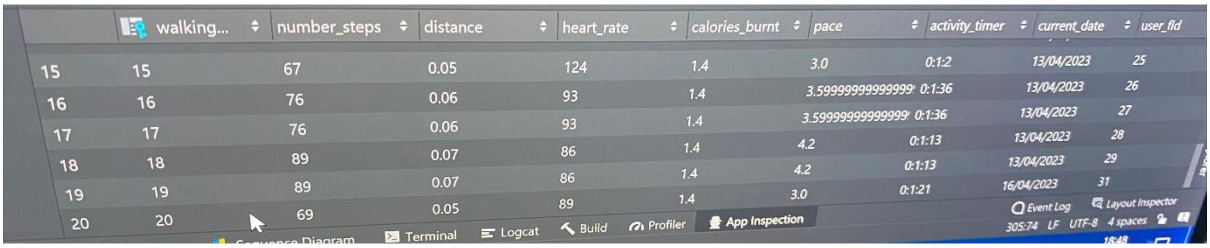
Figure 80 Testing walking activity

Figure 81 Testing walking activity



	user_id	gender	age	weight	height	count_go...
6	26	Male	20	80.0	183.0	5100
27	27	Male	20	80.0	183.0	5100
28	28	Male	20	80.0	183.0	5100
29	29	Male	20	80.0	183.0	5100
30	30	Male	20	80.0	183.0	5100
31	31	Male	20	80.0	183.0	5100

Figure 82 user data is inserted inside the user table shown in the last record



	walking...	number_steps	distance	heart_rate	calories_burnt	pace	activity_timer	current_date	user_fid
15	15	67	0.05	124	1.4	3.0	0:1:2	13/04/2023	25
16	16	76	0.06	93	1.4	3.59999999999999	0:1:36	13/04/2023	26
17	17	76	0.06	93	1.4	3.59999999999999	0:1:36	13/04/2023	27
18	18	89	0.07	86	1.4	4.2	0:1:13	13/04/2023	28
19	19	89	0.07	86	1.4	4.2	0:1:13	13/04/2023	29
20	20	69	0.05	89	1.4	3.0	0:1:21	16/04/2023	31

Figure 83 In the last record the walking activity has been inserted in the walking table

2. White Box Testing

Unit Testing

Test case 1

Pre-Condition:

Activity goals: 5000

Gender : Male

Age: 22 years old

Weight: 80kg

Height: 182cm

Step No	Test Objective	Step description	Test Data	Expected Result	Result
1	Message Apply displayed in profile screen	a. Enter user detail b. Click button apply	Valid user details	A message is displayed saying Apply changed	Successful

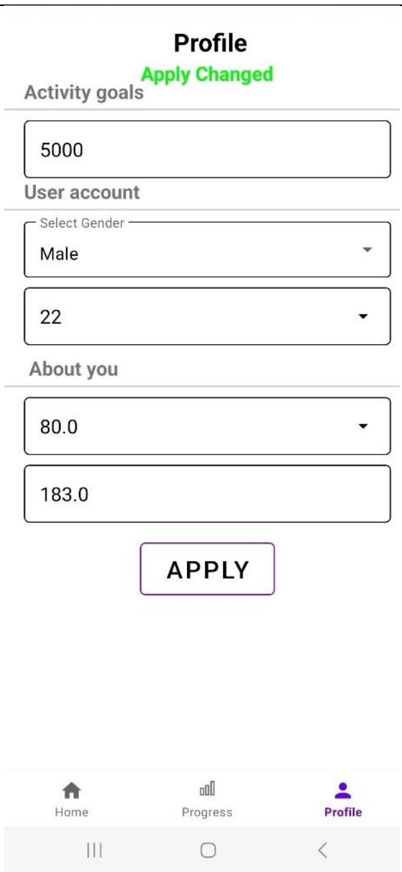


Figure 84 Successfully sent data

Table 7 White Box test case 1

Testing case 2

Pre-Condition:

Activity goals: 5100

Gender : Male

Age: 20 years old

Weight: 80kg

Height:

Step No	Test Objective	Step description	Test Data	Expected Result	Result
2	Error message on unsuccessful in the profile page	a. Don't enter user details	Empty user fields	An error message is displayed saying Please enter all the fields	Successful

		b. Click button apply			

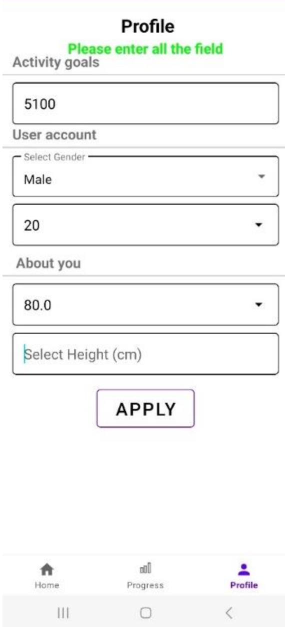


Figure 85 error message

Table 8 White Box test case 2

3. Black Box Testing

Unit Testing

Functional Requirments

1. user details in the profile screen

Requirments	Status
a. The system should allow user to enter their user detail in the profile page	Successful

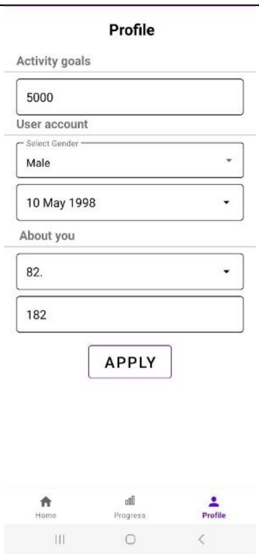


Figure 86 enter user data

Table 9 Black Box Testing 1 a

Requirments	Status
b. The system should display an error message when user don't fill all the fields	Successful

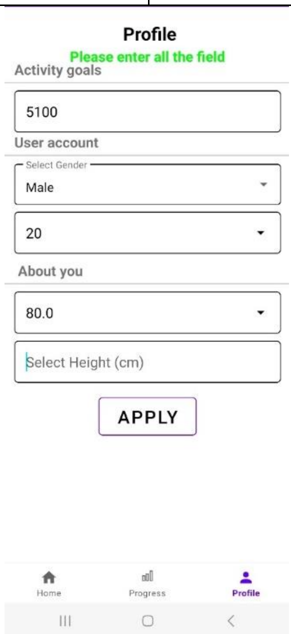


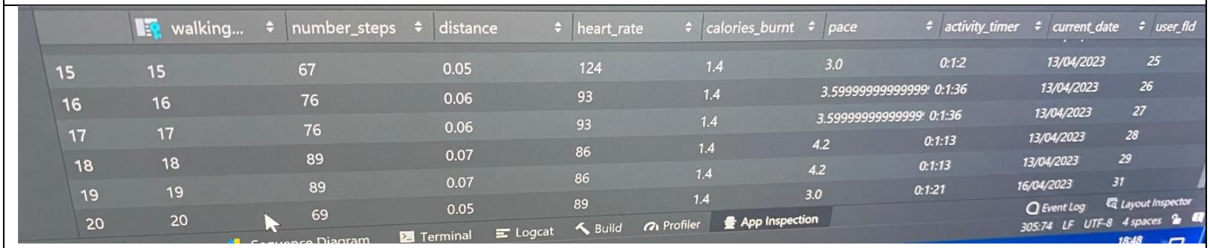
Figure 87 error message

Table 10 Black Box Testing 1 b

2. The system must store walking activity data inside the database

Requirments	Status

The system must store and save walking activity data inside the database after completing an activity.	Successful



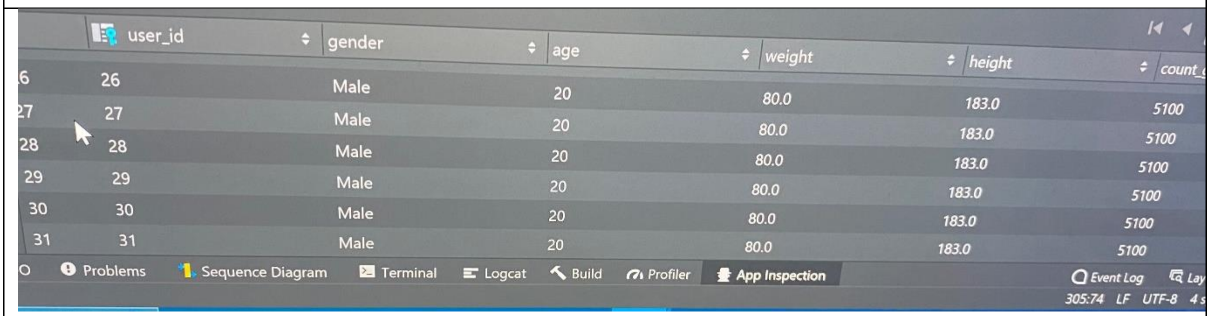
	walking...	number_steps	distance	heart_rate	calories_burnt	pace	activity_timer	current_date	user_fId
15	15	67	0.05	124	1.4	3.0	0:1:2	13/04/2023	25
16	16	76	0.06	93	1.4	3.59999999999999	0:1:36	13/04/2023	26
17	17	76	0.06	93	1.4	3.59999999999999	0:1:36	13/04/2023	27
18	18	89	0.07	86	1.4	4.2	0:1:13	13/04/2023	28
19	19	89	0.07	86	1.4	4.2	0:1:13	13/04/2023	29
20	20	69	0.05	89	1.4	3.0	0:1:21	16/04/2023	31

Figure 88 walking table

Table 11 Testing case 2

3. The system must store user data inside the database

Requirments	Status
The system must store and save user data inside the database after completing an activity.	Successful



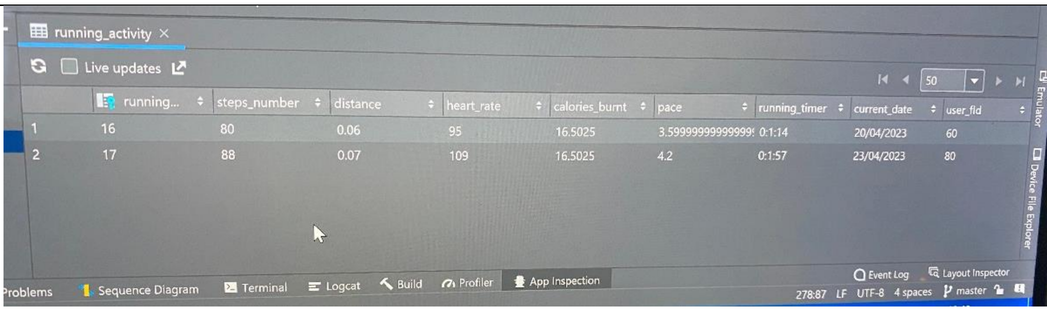
	user_id	gender	age	weight	height	count_
6	26	Male	20	80.0	183.0	5100
27	27	Male	20	80.0	183.0	5100
28	28	Male	20	80.0	183.0	5100
29	29	Male	20	80.0	183.0	5100
30	30	Male	20	80.0	183.0	5100
31	31	Male	20	80.0	183.0	5100

Figure 89 user table

Table 12 Testing case 3

4. The system must store running activity inside the database

Requirments	Status
The system must store and save running activity data inside the database after completing the activity.	Successful



running_activity

	running...	steps_number	distance	heart_rate	calories_burnt	pace	running_timer	current_date	user_fid
1	16	80	0.06	95	16.5025	3.599999999999999	0:1:14	20/04/2023	60
2	17	88	0.07	109	16.5025	4.2	0:1:57	23/04/2023	80

Table 13 Testing case 4

5. The system must show recent activities in the progress screen

Requirments	Status
The system must show recent activities in the progress screen after completing an activity.	Successful

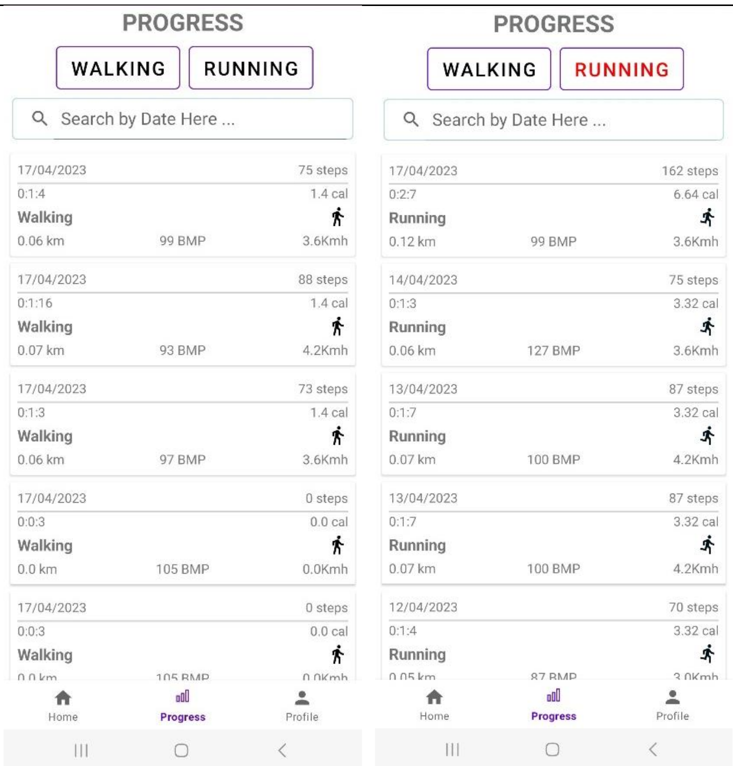


Figure 90 progress screen

Table 14 Testing case 5

6. The system must show the latest walking activity in the home page

Requirments	Status

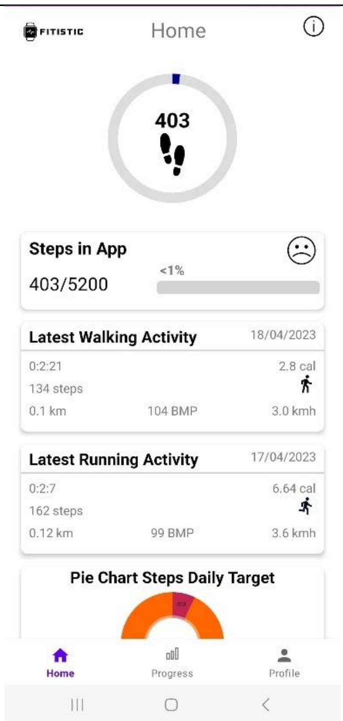
<table>
<tr><td>The system must show the most recent walking activity in the progress screen after completing an activity.</td><td>Successful</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">


Figure 91 home screen
</td></tr>
</table>

Table 15 Testing case 6

7. The system must show the latest walking activity in the home page

Requirments	Status
The system must show the most recent running activity in the progress screen after completing an activity.	Successful

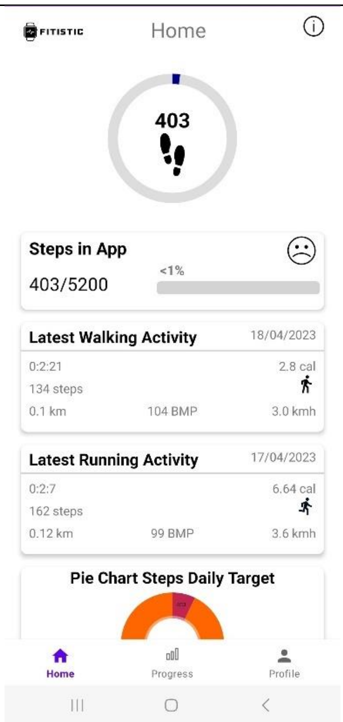


Figure 92 progress screen

Table 16 Testing case 7

8. The system must show the number of steps taken while exercising in the home screen

Requirments	Status
The system must show the number of steps taken while exercising in the home screen	Successful

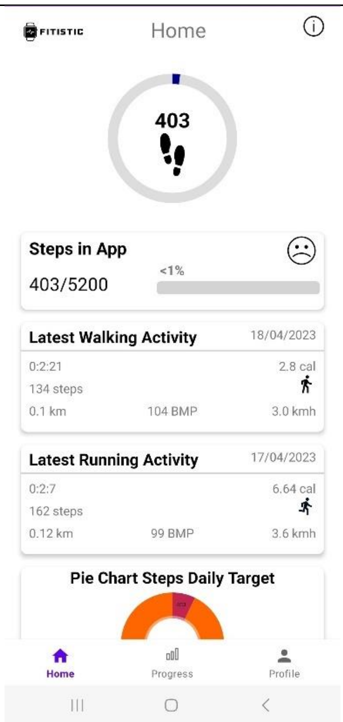


Figure 93 homes screen

Table 17 Testing case 8

9. The system must show the pie chart after completing at least one activity

Requirments	Status
The system must show the pie chart after completing at least one activity	Successful

Figure 94 home screen

Table 18 Testing case 9

10. The system must show the number of minutes you have walked and run

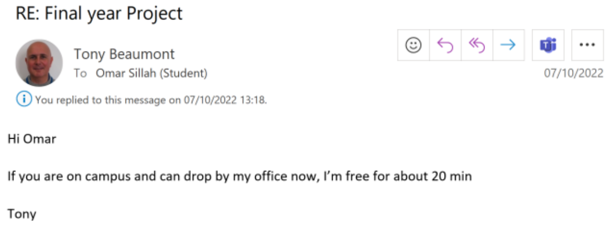
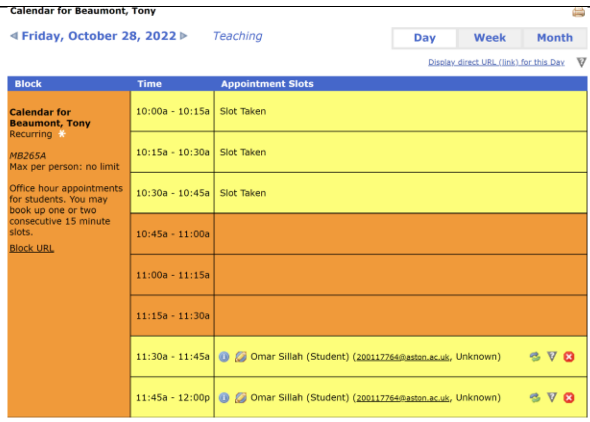
Requirments	Status
The system must show the number of minutes you have walked and run in the NHS recommendation.	Successful

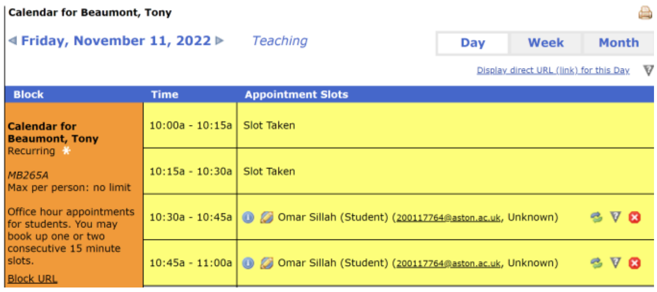
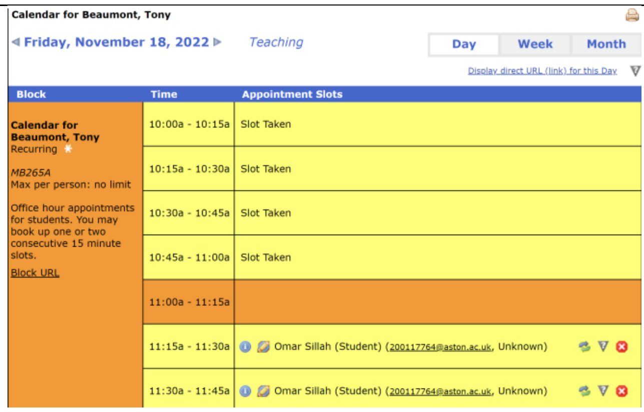
Figure 95 home screen

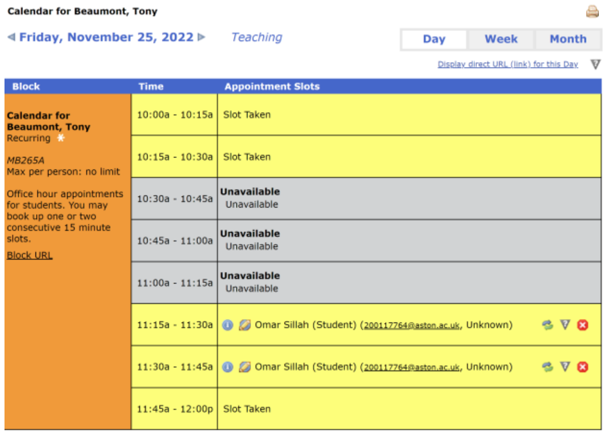
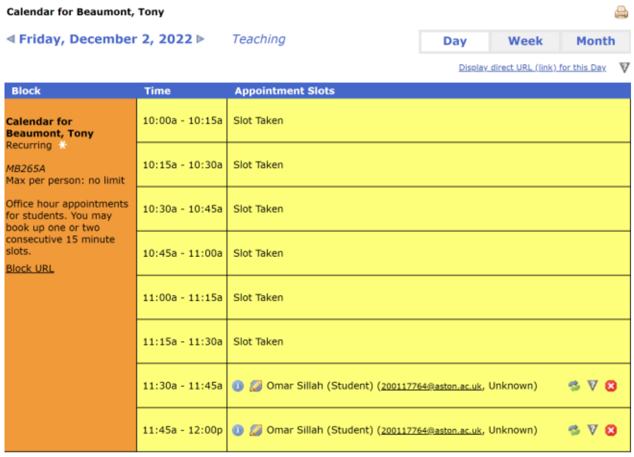
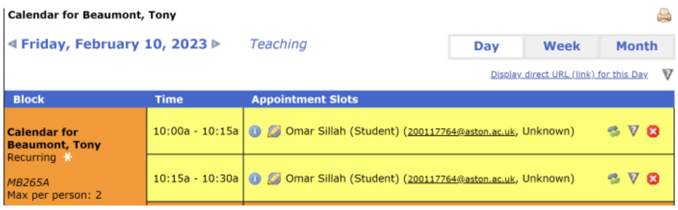
Table 19 Testing case 10

Appendix E

1. Project Diary

No	Date	Duration (minutes)	Description	Evidence
1	07/10	20	The discussion in the meeting was about the upcoming project definition form submission and about how I should start working on the introduction chapter.	 *Figure 96 evidence 1*
2	14/10/22	30	The discussion in the meeting about including a section that shows the structure of the report and reviewing the project definition form before submitting it.	 *Figure 97 evidence 2*
3	21/10/2022	30	I was not able to meet the supervisor due being feel ill during the week	
4	28/10/22	30	The discussion in the meeting was about the upcoming poster form submission as well as What I should include In the background research stage like researching about sensors , the best wearable on the market.	 *Figure 98 evidence 4*

5	04/11/2022	30	The discussion in the meeting was about if I should research about different type of watches (android ,IOS, fitbit) and comparing them.	 *Figure 99 evidence 5*
6	11/11/2022	30	We discussed about adding a section where I research about different sensors , their usage and what sensors I ‘m going to use.	 *Figure 100 evidence 6*
7	18/11/2022	30	We discussed about how I should include a step detector instead of using accelerometer to count steps due the difficulties and less accuracy that accelerometer provide .We also discussing in including referencing to great tutorial for implementing the sensors.	 *Figure 101 evidence 7*

8	25/11/2022	30	We discussed about how I should complete the wearable section by talking the difference between using gps distance and formula to calculate the distance travelled. We also discussed to include a section where I talk why I decided to develop on android instead of IOS.	 Figure 102 evidence 8
9	02/12/2022	30	We started to discussed more in depth what I should start to include in the design phase, including methodology used ,explaining the Gantt chart .We also discussed about the marking scheme and what I should do to get a higher mark.	 Figure 103 evidence 9
10	09/12/2022	30	We discussed about how I should do my term 1 report .We also discussed how I need to be more concise in the background research .We also discussed that the methodology that I'm going to use is the evolutionary prototype.	 Figure 104 evidence 10
11	10/02/2023	30	We discussed about what I should adjust in the background research such as organising better the sections in the background research and what I should do in the first prototype version 1 like creating	 Figure 105 evidence 11

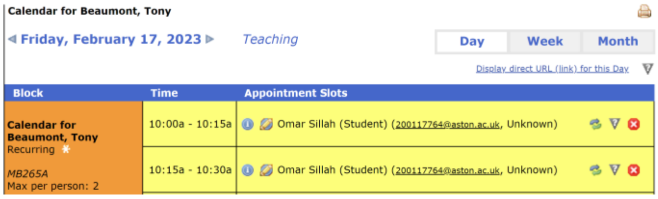
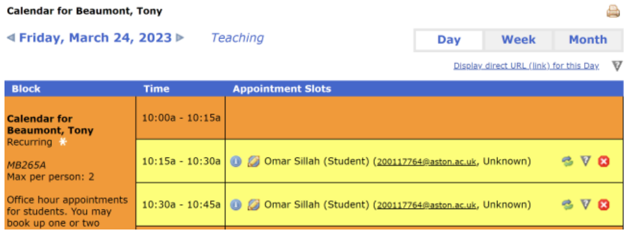
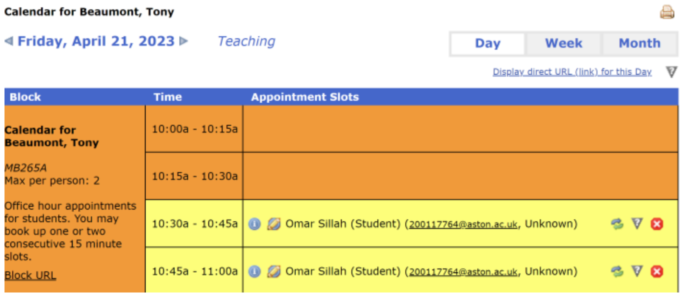
			an app that connect the smartphone app to the watch app and send a message that say connected. The prototype should be completed in one week.	
12	17/02/2023	30	We discussed about the challenging I faced while trying to make the phone app sending data to the watch app and the possible solution to complete the first prototype.	 Figure 106 evidence 12
13	24/03/2023		We discussed about what I should do after completing the second prototype(the system development) and we also discussed more about how I should spend some time thinking about the database model and how I could implement the database to complete the second prototype.	 Figure 107 evidence 13
14	21/04/2023	30	We discussed about how I should finish the report and , by finishing the conclusion and cleaning up some sections that need to be revisited.	 Figure 108 evidence 14

Table 20 Project Diary