Final Year Project, Research Manual, Gym Personal Training & Analytics App.

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1. Abstract

The purpose of this project is to create a cross platform (Android & iOS) application which will enable personal trainers or coaches to interact with their clients or players via mobile. They can manage their client's workout plans and see how they are progressing with each workout completed. They will also be able to provide meal plans and nutritional advice. Additionally, users will be able to create and edit their own plans using the app without interacting with a coach or personal trainer. Machine learning will also be implemented in a way which will analyse the user's data and give relevant feedback to improve time spent in the gym and the goal of using this app, to get healthier.

This document will cover all the research I undertook during the development of my app. It will cover the different technologies I considered to use including Python, React Native, Ionic, TensorFlow and more.

2. Introduction

The goal of this project is to create an environment where personal trainers and coaches can manage their clients and players' fitness regimes in one place. As personal trainers can be quite expensive and time demanding, many people will be reluctant to get on board with a trainer as they don't have the time or money. COVID-19 is another big reason behind why people might not want to train with personal trainers as for a long time with lockdowns, they simply could not. However, as the world adapted to this new way of living, many trainers were forced to move their business online by selling workout plans to people instead of getting them to come and train in person. This application will provide a space where trainers can manage these online plans easily and keep up to date with their clients without having to text and ask them how they got on. The client's data will be filled in during the workout and the trainer can see how they are progressing.

This application is not just aimed at personal trainers but for coaches of sports teams with many players to manage. They can give their players a specific meal plan they want them to follow and can track their progress as the players update their data.

As a sizable market for this type of application already exists, there are already several very well-built applications that let you do these things already, so why would people use my application over someone else's? Well, to answer this question I need to make sure my application is up to a good standard delivering all of these functionalities with a clean and easy to understand user interface (UI). A clean and user-friendly UI is a must for this application because if the user can't understand how to use the features or they feel like the data is messy and hard to organise, then why shouldn't they just use a notebook to keep track? Ticking all of the right boxes is essential to make this application successful and useful.

Integrating machine learning into this app will enable us to provide a more personalized experience for our users. The ability to evaluate a user's workout and provide feedback, or predict a user's weight will be invaluable in helping our users achieve their fitness goals. By leveraging the power of machine learning, we can provide more accurate and relevant insights to our users, making their experience with the app more valuable and informative. With the help of machine learning, we can create a more intelligent app that learns from its users and provides personalized recommendations and insights. This technology can help us take our app to the next level and provide our users with a truly unique and valuable experience.

3. Similar Applications

3.1 Jefit

Jefit is a renowned social workout tracking platform that analyses and tracks users' fitness objectives in order to keep them motivated. It is one of the most popular health and fitness apps in the app store and has over 8 million downloads worldwide across its iOS and Android apps [1]. Some of the main features Jefit provide are:

- Fully customizable workouts.
- Selecting from pre-existing workouts.
- Upload data and track your health progress.
- Interact and comment on plans shared by other people.

Although Jefit is a highly popular and successful workout managing application, it does not have the ability to view diet plans or track any nutritional information. Apart from this downside, Jefit is a very easy to use app with a very user-friendly interface. Below are some screenshots from the Jefit application which show the exercise screen and the workout plans screen. These show a very simple, straightforward screen where the user can pick and choose exercise for whatever body part they want very easily. I also aim to achieve this simplicity with my application. In my plans section, any workouts that have been created by the user or sample workouts the user has saved will appear here making it extremely easy to manage and keep all your different workout plans in one place.

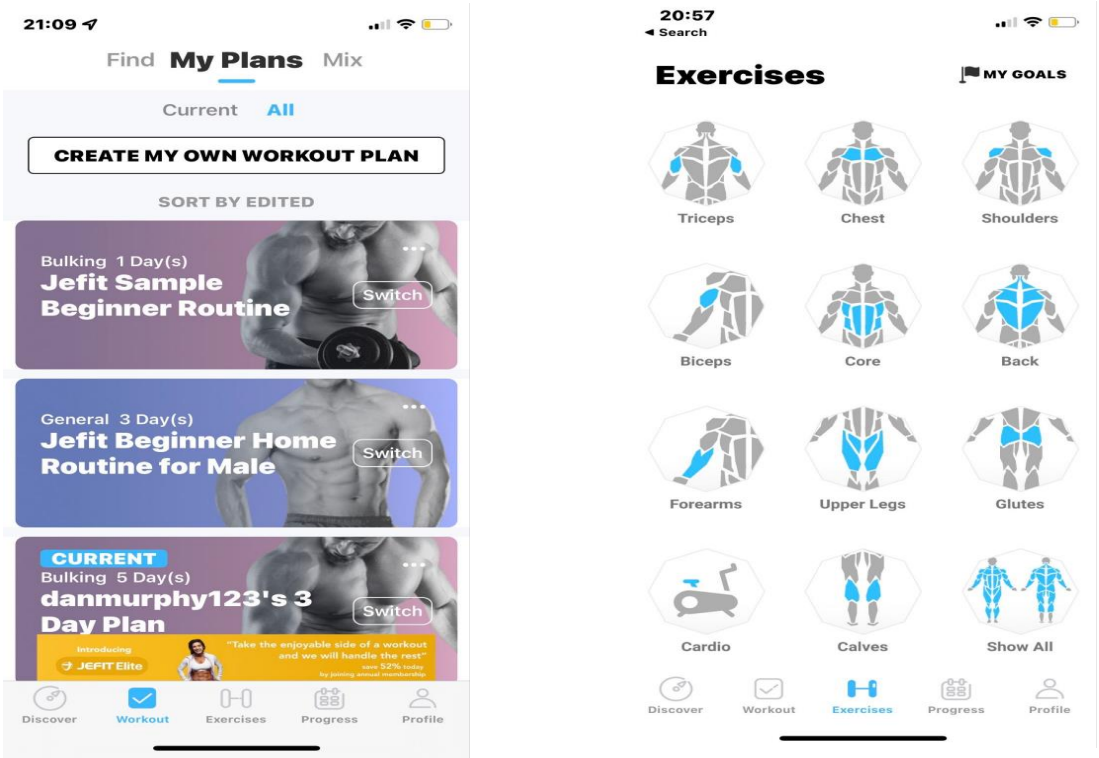

Figure 1 Jefit UI

3.2 MyFitnessPal

MyFitnessPal is an app that helps users measure their caloric intake, keep track of their progress toward weight-management objectives, and get encouragement from an online community. Since its debut in 2005, it has amassed an estimated 200 million users.[2] It focuses heavily on dietary control and leans more towards the weight loss and healthy eating side of fitness. It offers a simple, visually pleasing UI that is incredibly easy to use.
Some of the main features MyFitnessPal provide are:

- Daily calorie intake tracker.
- Recording daily workouts - This is a premium feature which means you must sign up and purchase a monthly or yearly plan.
- An online social platform where users may interact with others and make status updates about their weight loss journey.

As MyFitnessPal is one of the most popular fitness apps, it does not have a lot to offer if you would like to customise or create your own workout. However, when it comes to calorie intake and tracking food, it is one of the best and easiest apps to use. Below are some screenshots from the calorie tracking screen and the news feed screen. The news feed is great for browsing other people's fitness posts and often can find very helpful information relating to your weight loss journey. For example, nice low-calorie recipes like seen in the screenshot. The calorie tracking screen shows how simple and easy it is for a user to track each of their meals or snacks for the day while relaying relevant information back to the user without them having to look for it. This level of simplicity and ease of use is what I aim to achieve in my diet tracking features in my app.

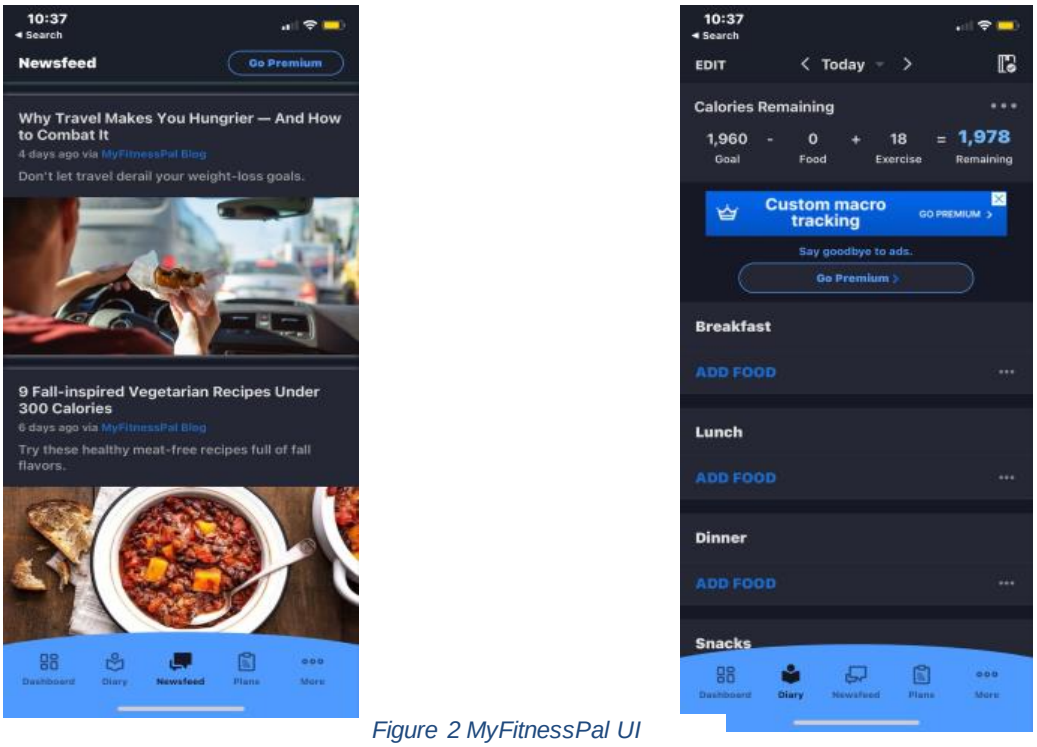

Figure 2 MyFitnessPal UI

4. Technologies Considered

This section of the research manual will go through all the various technologies and development tools for developing the application. This section will do research to see whether technologies have been utilised to produce comparable applications and to determine which technologies would fit my application. The goal of this project is to create an application which allows personal trainers or coaches to interact with clients or players and provide feedback to the user.
This section will go through the most useful technologies for accomplishing this objective.

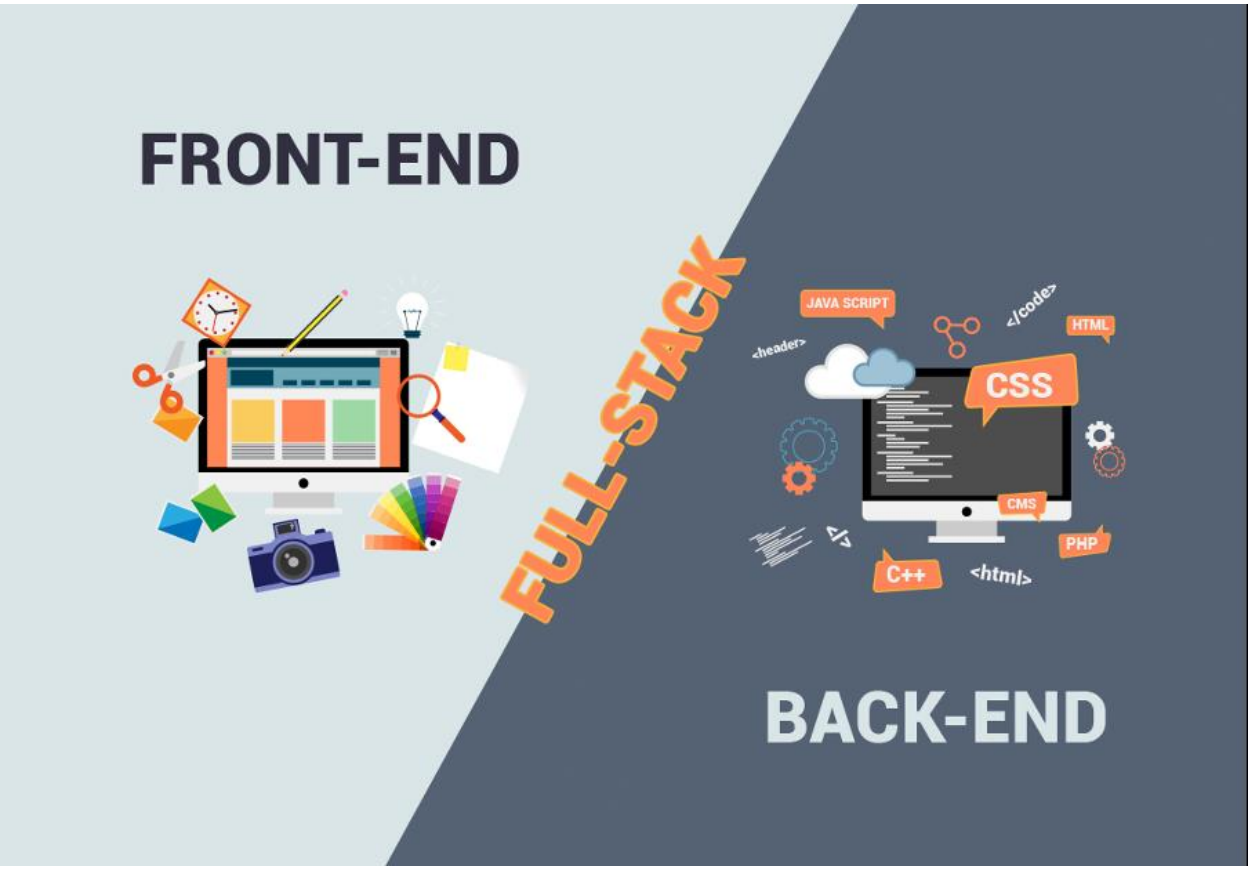

Figure 3 Front & Back-end technologies [26]

4.1 Frontend Technologies

4.1.1 React Native

Figure 4 React Native [27]

React Native is an open-source frontend framework which was developed by Facebook. It is based on the JavaScript library React and allows for cross-platform mobile app development while housing all of the code in a single codebase.[3] This makes React Native a very popular choice for developers as they can easily reuse code and the same underlying architecture for each platform as the principle for React Native is "Write once, run anywhere".[5] For both iOS and Android, React Native develops applications utilising JavaScript and the JSX syntax (a version of XML). It accomplishes this by rendering native APs in Java for Android and Objective-C for iOS.[4]

Some of the reasons why I would use React Native to develop my app include:

- Having one codebase for all platforms saves time I can put into other areas of the project bringing the quality up.
- It has been around since 2015 and has a huge community behind it. This means there are many resources available online with many libraries, template projects and discussion boards.
- React Native combines its own JavaScript with the native user interface's building blocks. This results in the user experience being substantially improved, and the app functions and looks like native app instead of a more website feel.
- Different styles for the app can be easily created on the server-side meaning I can personalise and style my apps UI with ease. [6]

Some of the downfalls of React Native include:

- If we were trying to build a complex UI for our app then React Native would not be much help as it thrives in simple UI design. The goal for this app is to create a simple UI that our users will understand so this should not be a problem here.
- The performance is slower than a traditional native app and it cannot utilise all of the functionalities a specific platform has.[7]

4.1.2 Flutter

Flutter is Google's open-source software development kit (SDK) which enables the development of high performance cross-platform desktop, mobile and online applications from a single codebase. It is built on the programming language Dart and offers a quick development process with hot reloading so you can edit your code right away. Being a complete SDK, Flutter comes with a rendering engine, pre-made widgets, testing, and integration APIs.[8]

Figure 5 Flutter [28]

Some reasons why I would use Flutter to develop my app include:

- Storing the code in a single codebase makes it easier to maintain while saving time as code does not need to be written more than once.
- Flutter code can run on desktop, mobile, and web platforms.
- Flutter uses a powerful UI engine which gives the developer complete control over the UI. *"The Flutter engine is so powerful that it can efficiently re-render UIs at a speed of* ***60 frames per second*** *(60 fps)"* [9]
- Google is known for creating well detailed documents and have provided excellent resources for learning.

Some of the downfalls of Flutter include:

- It is built on the Dart programming language. Not many developers will choose Dart to learn as it is not among the top programming languages [10]. Although it is frequently mentioned as the most powerful and useful aspect of the technology, this can deter people from using Flutter as they might be more comfortable using a framework that uses a language like JavaScript.
- As Flutter is still a relatively new technology, there is a limited number of third-party libraries and community support available. Consequently, there is a greater likelihood you will run into a problem nobody else has and that can be quite difficult to find support. Furthermore, are not a huge number of developers out there that can help on discussion boards This is a problem which will become less significant over time.[11]

4.1.3 Ionic

Ionic framework was released in 2013 and is an open-source front-end SDK that allows you to use the same codebase to construct mobile-based applications for iOS, Windows, and Android phones.[12] Ionic allows you to construct hybrid mobile applications using languages such as HTML, CSS, JavaScript, Angular, and Typescript. Hybrid applications consist of a web view wrapped in a native container that runs and acts like a web app. Ionic uses Cordova or Capacitor which acts like a native bridge for compiling UI elements.

Figure 6 Ionic [29]

Some reasons why I would use Ionic to develop my app include:

- There is a single codebase for both mobile and web applications. This saves time as writing multiple pieces of code is time consuming.
- Ionic is considered an easy tool to learn. As it uses popular languages such as HTML and JavaScript. These are programming languages which developers tend to start out learning and having experience in these will make it easier to get a grasp of the basics.
- Ionic has a strong community with over 5 million developers and lots of activity on discussion boards and online forums to answer any questions that the documentation might not cover.

Some of the downfalls of Ionic include:

- Ionic renders its graphic elements via browser. As we add more code and our project grows, this could lead to slower performance then a native app.
- Ionic is very dependent on plugins. Although there are a large number of plugins and packages available, if you need a highly specific feature, it might be hard to find and will have to develop your own. [13]

4.1.4 Figma

Figma is a web-based application which allows you to design and edit a user interface all while working on your browser. This means you can access your projects and begin designing from any computer or platform without purchasing additional licences or installing software. [23] Figma is only used for designing your applications UI and does not involve any coding.

Figure 7 Figma [30]

4.1.5 React Native vs Ionic vs Flutter.

There are many reasons why each of these technologies are a good fit for my application as all of them provide the ability for cross-platform development with a single codebase.

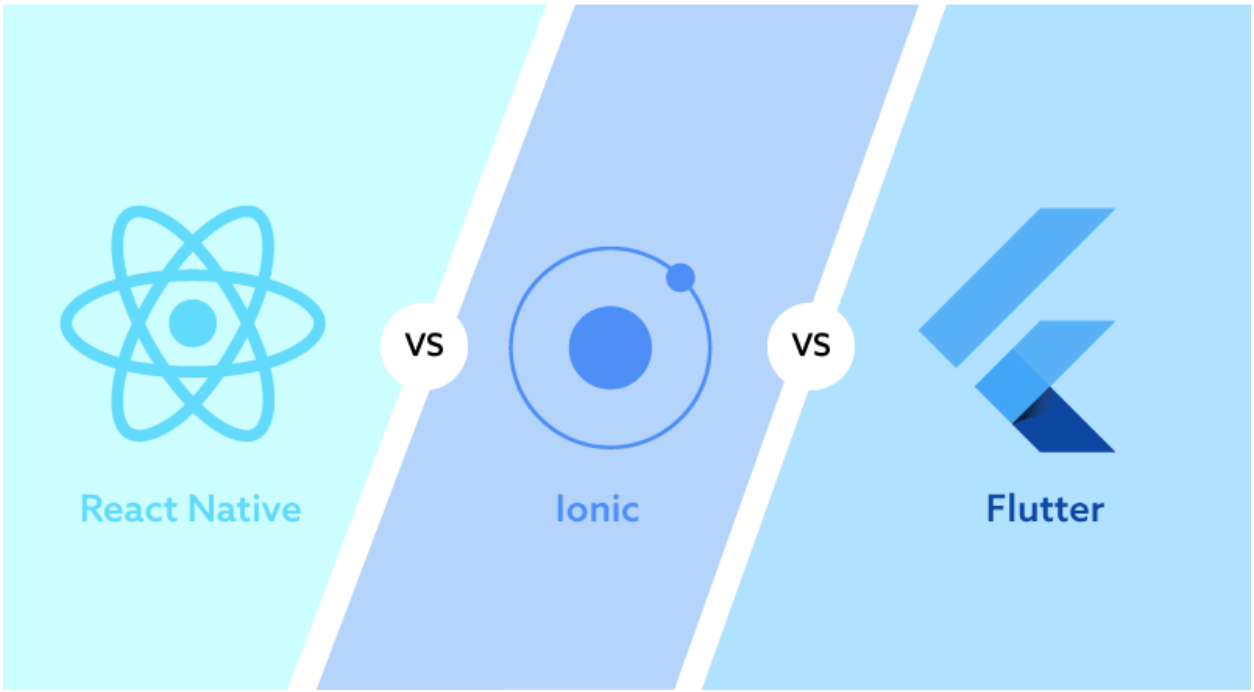

Figure 8 React Native vs Ionic vs Flutter [31]

React Native offers a real native app experience and uses React framework and JavaScript while Ionic takes more of a web-based approach utilising web technologies like HTML, CSS and JavaScript. A Cordova or Capacitor plugin is required to put the web application in a native container. Flutter, on the other hand, is unique as it uses the Dart programming language and provides a powerful UI engine.

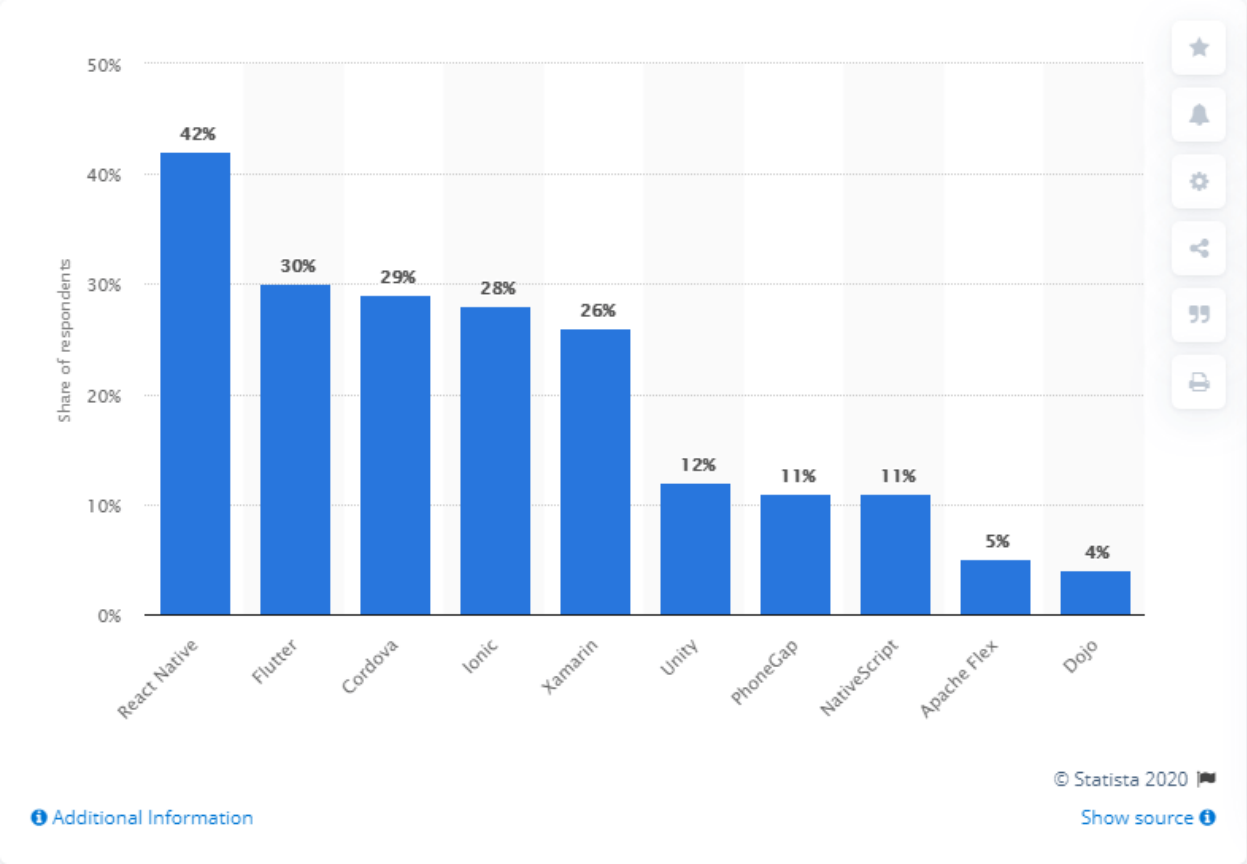

Figure 9 Front end framework popularity chart [32]

As we can see from the above chart, it can be hard to choose which front end cross platform framework will be best for this application as there are many popular choices. React Native is clearly the most popular at 42%. This could be for many reasons as React Native tends to be more secure and stable as the project scales up. Flutter is not far behind at 30%. As Flutter is the newest out of the technologies, it does not offer the stability and community support that React Native does. Ionic however, has only 28%. Although Ionic offers a better community support and a good platform to scale the project, it does not give off the same Native app feel that Flutter and React Native provide as it works as a hybrid app wrapping your web view in a native container to deliver a Native app feel.

4.2 Backend Technologies

4.2.1 Flask

Flask is an open-source Python-based web application framework. It is based on the Web Server Gateway Interface (WSGI) toolkit and the jinja2 template engine. Flask is often referred to as a microframework. This means it does not rely on other tools or libraries in order to function. For this project, I can use Flask to create a REST API which will interact with a front-end technology.[14]

Figure 10 Flask [33]

Some reasons why I would use Flask to develop my app include:

- It has the potential to scale the project very quickly. It allows projects in which you have an app that starts small but has the potential to develop fast and in ways you haven't fully thought out yet. Its ease of usage and few dependencies allow it to function smoothly even as it scales up and up. Therefore, it would suit my application as I am taking an agile approach.
- The microframework is simple to comprehend for web developers, saving them time and effort while also offering them more control over the code and its potential.

Some of the downfalls of Flask include:

- One of the main disadvantages of Flask is that it doesn't have a big selection of tools and libraries. This means you must add extensions and libraries manually. Adding lots of libraries can then slow down the app and affect its performance.[16]
- There is no admin site. This helps us see the models we create and perform CRUD actions with our database. There is a library which works around this and gives you an admin site in flask but as mentioned before, this can slow down the overall performance of the app.

4.2.2 Django

Figure 11 Django [34]

Django is an open-source python-based web framework that encourages quick and clean development. It offers a set of modules that let programmers customise pre-existing sources rather than creating a website from scratch. This is because Django is all about rapid development and the delivery of uncomplicated, practical designs. It also comes with a wide range of features and functionalities like a free API, database migrations and more.

Some reasons I would use Django to develop my app include:

- Django is very versatile and allows for the creation of a wide variety of web applications so I can easily tailor it for my app.
- The Django community is strong with over 32,000 companies using Django.[16] This means there will be support on discussion boards about many problems that arise.
- Django has an automatic admin interface. This lets the user access the models and manage CRUD operations with ease and simplicity. This admin site comes with a pre-built authentication functionality.
- Django offers security with a very small possibility of security loopholes and prevents common attacks like SQL injection and cross site scripting.

Some of the downfalls to Django include:

- It lacks convention. This means everything has a specific way to define and perform tasks like file structuring.
- There is a steep learning curve and although it is a clear, simple framework and easy to set up, developers can find it difficult to master all of the features and configurations. [17]

4.3 Machine Learning Technologies

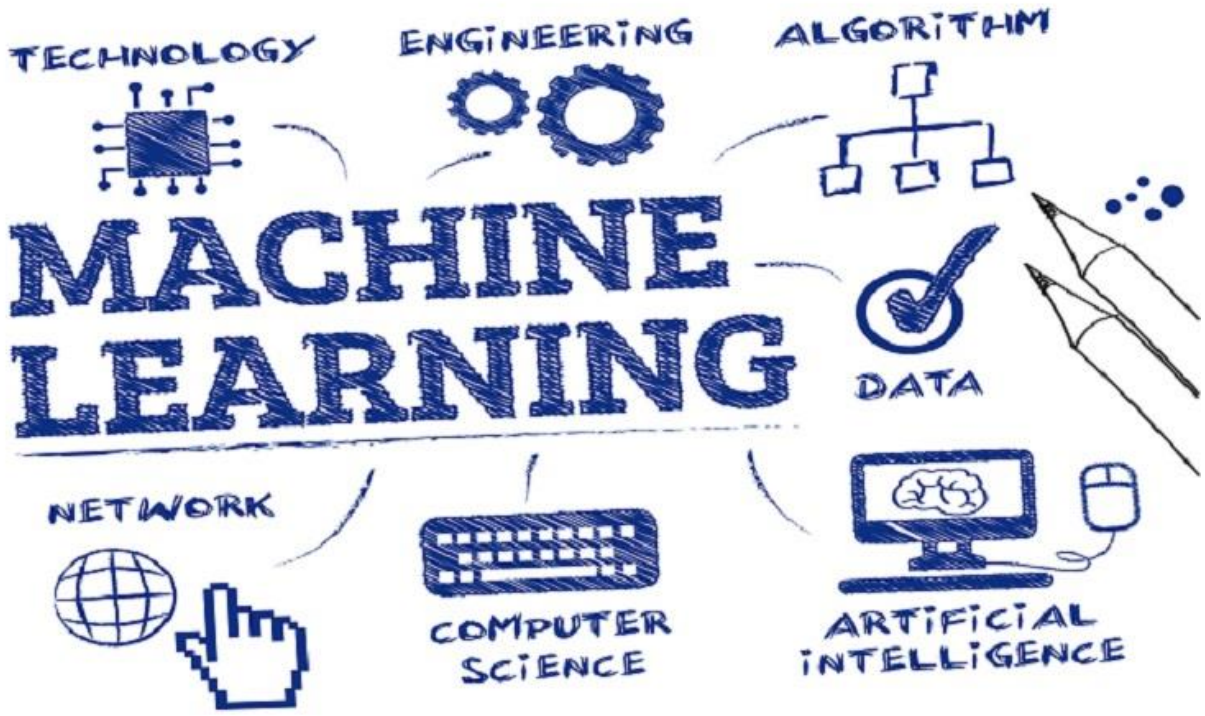

Figure 12 Machine learning technologies [35]

4.3.1 Pandas

Pandas is a popular open-source Python library for analysing data and machine learning activities. It is constructed on top of NumPy, another library that supports multidimensional arrays. Pandas is also very compatible with many other data science modules which contributes to its popularity.[18]

Figure 13 Pandas [36]

4.3.2 Keras

Keras is an open-source high-level deep learning API for creating neural networks. It is built by Google in Python and is used as a programming interface to make neural network construction simple. It also uses TensorFlow technology to create machine learning models.[19]

Figure 14 Keras [37]

4.3.3 PyTorch

PyTorch is an open-source framework built on the foundations of Python and the Torch library. It is one of the most popular platforms for machine learning research and is designed to accelerate the process between research prototyping and deployment. [20]

Figure 15 PyTorch [38]

4.3.4 TensorFlow

TensorFlow is an open-source machine learning application framework developed by Google. It is a maths toolkit that uses dataflow and programming to handle various tasks related to deep neural network training. It enables developers to build machine learning applications by using tensors which are multidimensional arrays. This allows for calculations on a massive scale and makes it one of the most popular deep learning libraries.[21]

Figure 16 TensorFlow [39]

4.3.5 Scikit Learn

Scikit Learn is a machine learning library which provides a set of efficient tools for machine learning and statistical modelling, like classification, regression, clustering and is delivered via a Python interface This Python-written package is based on NumPy, SciPy, and Matplotlib [40].

Figure 17 Scikit Learn [40]

4.4 Cloud and Database Infrastructure.

4.4.1 Heroku

Heroku is a cloud service platform which allows users to develop and deploy applications. It's a system for providing universal access to shared pools of customizable resources, including servers, storage, networks, applications, and services. It acts as a Platform as a Service (PaaS). This means it hosts hardware and software on its own infrastructure and provides these tools for application development [24].

Figure 18 Heroku [41]

4.4.2 Firebase

Firebase is a Backend as a Service (BaaS). This means it provides a connection to backend cloud storage and APIs. Firebase is built on Google's infrastructure and helps develop apps by providing a variety of tools and services. It can be categorised as a NoSQL database and provides many important features for your app like authentication and hosting [25]. One of the main benefits of using Firebase is its ease of use, which allows developers to quickly set up and implement features such as user authentication, database management, and real-time data synchronization without having to build these features from scratch. Another benefit of Firebase is its scalability, which enables developers to manage large amounts of users and significant traffic loads with ease. Firebase also provides a variety of analytics and performance monitoring tools that may assist developers in understanding how their application is being used and identifying areas for improvement [46]. Although Firebase has many advantages it does have several disadvantages.

Figure 19 Firebase [42]

One of the biggest disadvantages of Firebase is that it saves data in a NoSQL format, which makes working with huge, complicated data sets challenging. Furthermore, Firebase offers limited support for server-side code, making it difficult to build some sorts of functionality.

4.5 Development Environment

4.5.1 Visual Studio Code

Figure 20 Visual Studio Code [44].

Microsoft's Visual Studio Code (VS Code) is a free, open-source code editor. It is frequently used by programmers to write and edit code in a variety of computer languages, including JavaScript, Python, and C++. The user-friendly interface of VS Code, which includes features such as syntax highlighting, code completion, and debugging tools, is one of its major strengths. Furthermore, VS Code offers a large number of adjustable features and extensions, allowing developers to customise the editor to their own requirements [43].

VS Code is also compatible with many platforms, supporting Windows, macOS, and Linux, making it a flexible choice for developers. It also integrates with other development tools and services, such as GitHub and Azure DevOps, making it a useful tool for collaborative development. The use of all these features together allow for a clean and tidy environment for you to code in. A simple menu to navigate between files easily, a terminal for you to compile and run your code and a fully customizable appearance make it a top choice for a lot of developers.

4.5.2 GitHub

Figure 21 GitHub [45]

GitHub is a web-based platform for developers which allows them to save, share, and collaborate on code projects. It is built on the Git version control system, which allows numerous developers to work on the same codebase at the same time all while tracking each developer's modifications. One of the primary advantages of utilizing GitHub is its ability to enable developer cooperation by allowing them to readily exchange and review code changes, as well as monitor and resolve issues [44].

GitHub also includes a number of other capabilities, such as the ability to store and read documentation, track project progress, and manage access rights for various people.
It also integrates with a variety of other development tools, including Visual Studio Code and Azure DevOps, making it a great tool for software development and this project.

4.6 Documentation

4.6.1 Doxygen

Figure 22 Doxygen [48]

Doxygen is a documentation generator tool for creating documentation for software projects written in a variety of programming languages. One of the primary advantages of using Doxygen is its ability to extract documentation straight from source code, which may save developers time and effort. Doxygen is also highly customizable, allowing developers to customize the documentation to their own needs. Doxygen also has the benefit of supporting a broad number of programming languages, including C++, Java, and Python [47]. Doxygen can provide documentation in a variety of forms, including HTML, LaTeX, and RTF.

However, Doxygen has several disadvantages. One of them is that accurate documentation necessitates a large quantity of commentary in the source code. Furthermore, for larger projects, Doxygen might be difficult to set up and configure. In summary, Doxygen is a useful tool for generating documentation for software projects, but it does have some limitations and drawbacks that should be taken into consideration.

4.6.2 JSDoc

Figure 23 – JSDoc [52]

JSDoc is a JavaScript API documentation generator, similar to JavaDoc or PHPDoc. Documentation comments are added straight to the source code, alongside the code itself. The JSDoc Tool will analyse your source code and create a fully functional HTML documentation page for you [52]. JSDoc supports the use of tags, making it easy for developers to provide detailed documentation for functions, classes, and other code elements. This also allows for better organization and customization of the generated documentation.

However, JSDoc does have some disadvantages. One notable limitation is that it only supports JavaScript, unlike other tools like Doxygen, which cater to a wider range of programming languages. Additionally, generating accurate and comprehensive documentation with JSDoc requires extensive use of comments within the source code, which could be cumbersome for some developers. Lastly, configuring JSDoc for larger projects may prove to be challenging. In conclusion, JSDoc is a powerful tool for generating documentation for JavaScript projects, but it has some limitations and drawbacks that should be taken into account when deciding on a documentation generator.

4.7 Payment System

4.7.1 Stripe

Figure 24: Stripe[50]

Stripe is a payment services company that allows companies to take credit and debit cards as well as other forms of payment. Stripe payments are best suited for companies who make the majority of their purchases online, as the majority of its unique features are focused exclusively on online sales. For this application, it could be used to take payment for a monthly fee [49].

Integrating Stripe into this application will allow for secure and seamless payment processing. Stripe provides an easy-to-use API that allows payment processing functionalities to be integrated directly into the app. To connect Stripe with the project, a developer must first create a Stripe account and receive API credentials. After this the developer may easily design a payment form in the app using Stripe's pre-built UI components. Stripe could interact with my backend server to store information relating to these payments and user credentials. Furthermore, Firebase offers prebuilt SDKs that allow for easy integration with Stripe along with detailed documentation.

5. Testing

Testing is an essential aspect of the software development process, especially for this application where accuracy and reliability are key. Manual testing and automated testing are the two basic forms of testing that can be performed on a this app.

5.1 Manual Testing

Manual testing for this app will involve a group of people using the app and providing feedback based on their experience. This type of testing is valuable because it allows developers to get real-time feedback from users and identify any issues that may have been missed during the development process. The group of testers will be as diverse as possible but there will be limits. It will try include people with different fitness levels and interests. They should be encouraged to provide honest and detailed feedback to help improve the app.

5.2 Automated Testing

In contrast, automated testing involves the use of testing frameworks, libraries, and tools to automatically test the app's functionality. In this case, developers may use a mix of React Native and Firebase testing frameworks and tools, such as Jest [51] and React Native Testing Library. Automated testing is critical since it aids in the detection of bugs early in the development phase. This lowers the likelihood of issues in production.

6. Conclusion

To conclude this research manual I will cover which technologies are best suited to the project. Although all of the technologies discussed might seem like a good fit, not all of them can be used. Therefore, through experimentation and deep research I have explained my decisions below. As this project is taking an agile approach, there is always a possibility some of these technologies will change.

6.1 Frontend Technologies

From the research carried out on frontend mobile app frameworks, React Native seems to be the best way to develop my app. It offers a real Native app feel to the design which Ionic does not offer. It also has the capabilities to scale the project as it gets larger and larger catering for as many users as possible.

Furthermore, it offers better community support then Flutter which will prove useful down the line as issues are bound to arise. and help or solutions can be found online.

React Native also has a hot reload function meaning I can develop my app and make changes to the code and see those changes in real time without having to reload my application whereas Ionic compels you to restart the app.

React Native seems to offer more stability than both other frameworks. Choosing React Native could save time and prevent any issues with stability and reliability further down the line.

6.2 Backend Technologies / Cloud and Database infrastructure

From researching each of these sections it showed quite an overlap with the two. For this project, Django seems like a good fit but will require a lot of work to setup and manage my own backend server. Firebase can provide a serverless architecture allowing me to retrieve my data from the Firestore cloud database. This would save a lot of time which can be used to improve other areas if the project. Both of these have built in authentication system which provide a good level of reliability and security.
Django is preferred over Flask as the research shows Flask does not scale up very well. This means that as the app grows in terms of size and users, performance and stability could be an issue.

Django also offers security and has very little security loopholes whereas Flask is veery weak on the security front. I am also familiar with Django which means more time can be spent learning other technologies and I can improve the standard in other areas of the app.

Overall, Firebase seems like the best for for this project for a number of reasons:

- Real-time data synchronization: Firebase offers real-time data synchronization, which means that any changes made to the database are instantly updated across all devices in real-time. This is a critical feature for mobile applications where users expect real-time updates.
- Serverless architecture: Firebase is a serverless architecture, which means that you do not have to manage or configure any servers, and you can focus on developing the front-end application. This reduces the complexity and time spent on server management.
- Integration with React Native: Firebase has good integration with React Native, and there are many libraries available to simplify the integration.

6.3 Machine Learning Technologies

While researching the machine learning technologies I found that many of them are suited to the functionality I require. Firstly, Python will have to be used as it is the number one machine learning programming language, and each framework uses Python so learning it for this project is a must.

From the research, Pandas is the way to get my data into a data frame so this will be used.

TensorFlow will also be used to train the model I decide as it is the most popular framework for this purpose with lots of resources to help if any issues arise.

The use of Scikit Learn will also be required as it is a library containing other Python maths packages, like NumPy and Matplotlib which will prove essential to the machine learning part of this project. It also provides Linear Regression methods which can be used to train a model to predict values like the users weight.

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