MSc Project: Mobile Hairdresser Application

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"A dissertation submitted to the University of Bristol in accordance with the requirements of the degree of Master of Science by advanced study in Computer Science in the Faculty of Engineering."

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Executive Summary

Acknowledgements

Author's Declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's Regulations and Code of Practice for Taught Programmes and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, this work is my own work. Work done in collaboration with, or with the assistance of others, is indicated as such. I have identified all material in this dissertation which is not my own work through appropriate referencing and acknowledgement. Where I have quoted or otherwise incorporated material which is the work of others, I have included the source in the references. Any views expressed in the dissertation, other than referenced material, are those of the author.

SIGNED: Joshua Robertson DATE: 14.09.2021

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1 Introduction

The COVID-19 pandemic has had a ubiquitous impact on our lives, from work, to travel, to how we socialise. Some of these changes are temporary, such as mask wearing, but others, such as the adoption of more digital services and flexible homeworking seem likely to be permanent (ADD CITE). Subsequently, the restriction of movement has caused consumers to migrate to online services at an unprecedented rate. With the global home services market expected to grow by almost 20% per year until 2026 [21] there exists a wealth of opportunity for companies to capitalise through digitalising previously physical services. One of these services is hairdressing, which saw a sizeable uptake in demand throughout the pandemic.

There already exists a range of applications suited towards providing home haircuts. For example, Shortcut [13], TRIM-IT[28] and TrimCheck[29] all provide bookable home haircuts. Despite this, none of the aforementioned applications follow the "uber" model, of allowing for immediate booking and delivery of home haircuts.

This application will therefore aim to facilitate this, along with exploring any other market gaps through early research and will aim to achieve this through the following objectives:

- Conduct research to elucidate any market gaps
- Through a user centric design (UCD) methodology plan and prototype the user interface of the application
- Create a minimum viable product (MVP) using new product development (NPD) methodologies

The research aspect of the project will aim to analyse the strength and weaknesses of existing applications within the field, therefore exposing any market gaps that may be present.

For the implementation of the application, a heavy focus on the end user was taken through using a UCD methodology, along with NPD, which refers to the entirety of processes leading to bringing a product to market and encompasses several steps as seen in figure 1 below and discussed throughout the proceeding sections.

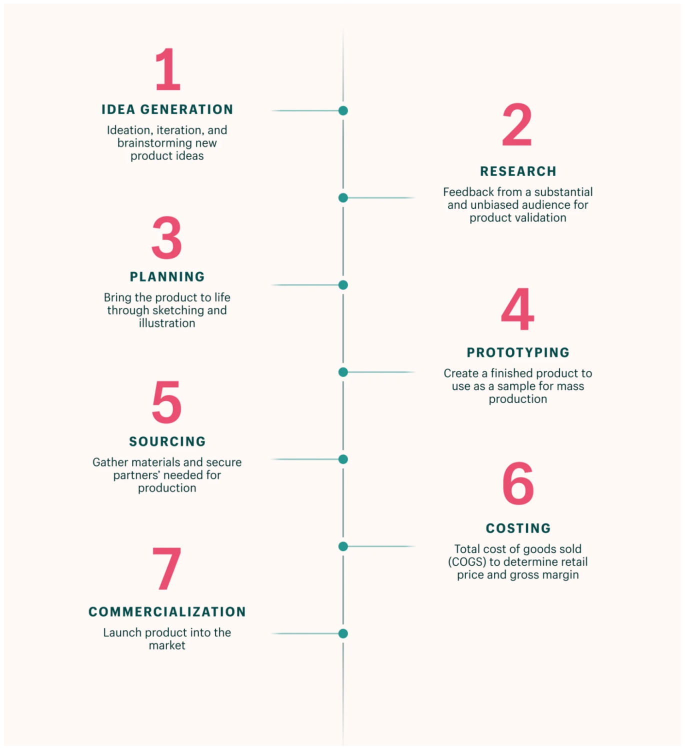

1
IDEA GENERATION
Ideation, iteration, and brainstorming new product ideas
2
RESEARCH
Feedback from a substantial and unbiased audience for product validation
3
PLANNING
Bring the product to life through sketching and illustration
4
PROTOTYPING
Create a finished product to use as a sample for mass production
5
SOURCING
Gather materials and secure partners' needed for production
6
COSTING
Total cost of goods sold (COGS) to determine retail price and gross margin
7
COMMERCIALIZATION
Launch product into the market

Figure 1: The 7 Steps of New Product Development
[24]

1.1 Ideation and Concept

The first stage of NPD starts with conceptualisation of a product idea. For the application the initial concept came from an external partner, who proposed a mobile hairdresser application to capitalise on the increased need for home delivery services. This was further defined during several meetings carried out in the initial stages of the project.

1.2 Project Management

The project management for the application focused on two key aspects; a clear vision and scope, including a detailed project plan; and an execution phase, which utilized an agile methodology.

1.2.1 Vision and Scope

The end goal of the project was as a springboard to create a fully functional and profitable barber delivery application.

The scope of the project was..

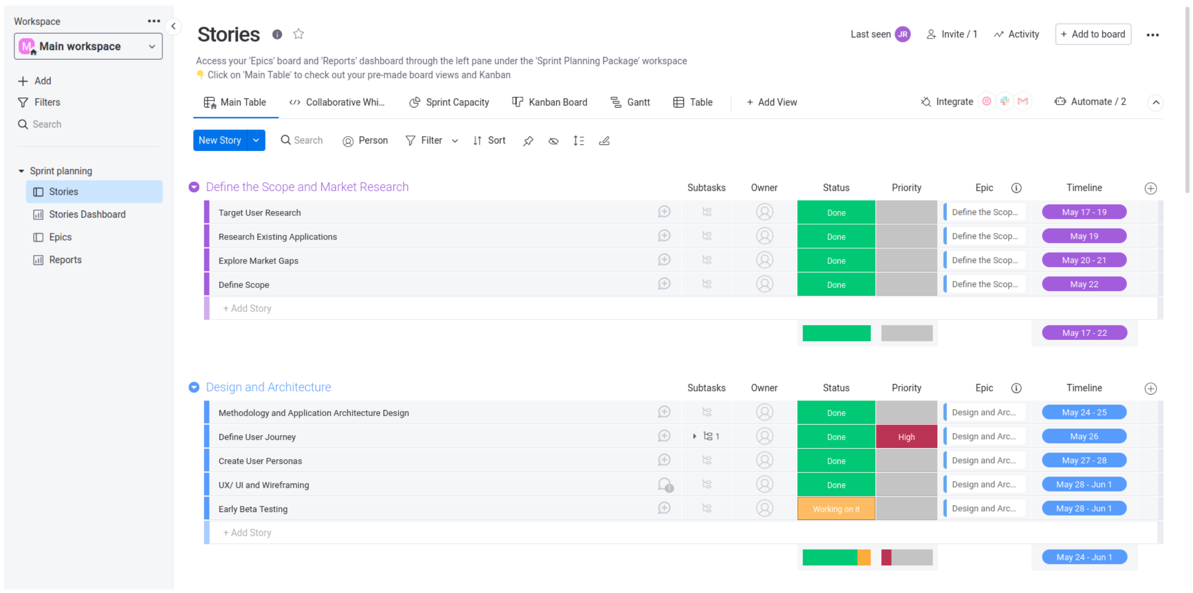
1.2.2 Agile Methodology

To carry out the project, an agile methodology was utilised, which allowed for short, iterative cycles of production, providing value in the form of quick creation and constant revision. Taking on an agile methodology also served the project well in the sense that there was a strong focus on prioritising value over comprehensive documentation and lengthy processes.

Although this approach is more commonly relevant to a team of developers, approaching the project management in this way allowed for a stringent and well defined timeline to be used, aiding in project delivery and outcome. This involved several key stages. Firstly, individual 'epics' were defined, which included:

- Define the Scope and Market Research
- Design and Architect the Application
- Setup and Create The Backend
- Write the Dissertation

These were then used to create 'stories' which were further split into individual tasks placed into a timeline and carried out in . For this, the project management tool monday.com [18] was used, which can be seen in figure 2. Using Monday.com allowed for a timeline to be easily created, along with updating the status of each story when relevant to follow the completion of the project. In this way, a change management approach (ADD CITE) could be carried out, in which the project could easily be updated and reflected in the tasks. This was especially important as both agile methodology and the UCD rely on constant feedback from the end user which informs the project.



Stories

Access your 'Epics' board and 'Reports' dashboard through the left pane under the 'Sprint Planning Package' workspace
Click on 'Main Table' to check out your pre-made board views and Kanban

Define the Scope and Market Research

	Subtasks	Owner	Status	Priority	Epic	Timeline
Target User Research			Done		Define the Scop...	May 17 - 19
Research Existing Applications			Done		Define the Scop...	May 19
Explore Market Gaps			Done		Define the Scop...	May 20 - 21
Define Scope			Done		Define the Scop...	May 22
+ Add Story						
						May 17 - 22

Design and Architecture

	Subtasks	Owner	Status	Priority	Epic	Timeline
Methodology and Application Architecture Design			Done		Design and Arc...	May 24 - 25
Define User Journey	1		Done	High	Design and Arc...	May 26
Create User Personas			Done		Design and Arc...	May 27 - 28
UX/ UI and Wireframing			Done		Design and Arc...	May 28 - Jun 1
Early Beta Testing			Working on it		Design and Arc...	May 28 - Jun 1
+ Add Story						
						May 24 - Jun 1

Figure 2: Screenshot of Monday.com Displaying the Project Stories [18]

Finally, using the created timeline, a gantt chart was implemented, which gave an overarching view of the project, with tasks performed represented along the vertical axis and the timeline represented along the horizontal axis. This can be found in the appendix (ADD CITE).

1.3 Research and Market Analysis

In order to gauge whether there is a market for the proposed analysis, a survey was carried out in which users were asked about whether they could see themselves using the application features, among other things. The full survey can be found within the appendix (ADD CITE)

1.3.1 Existing Applications

As previously discusses there exists a variety of similar applications, for which the most prominent will be discussed below, along with the salient and limiting features of each.
TODO: finish this section

Shortcut
Shortcut is a US based application.. One of the defining features of the shortcut app is the availability, with the app providing the ability to request a haircut from 8am to as late as midnight capatilising on a previously unventured late night hair cut market.

The application is limited on it's features, with it only having the option to request a Hair Cut only or a Hair Cut and Beard Trim. Another limiting feature of the application is the price. For a single haircut the cost starts at 75$ (around £54), which is most likely a reflection of high start up costs and is a problem seen in other similar applications, such as uber and lyft that can only be mitigated through losses ([30]).

TRIM-IT https://www.bbc.co.uk/news/stories-47711610 TODO: discuss more here
TRIM-IT is a UK based mobile hairdressor application. Their business model is franchise based similar to that seen by Mcdonald's, whereby barbers would invest through a monthly fee and be provided with the tools necessary, such as a mobile barber unit.
TrimCheck

1.3.2 Novelty of the Proposed Application

As discussed in the previous sections, there exists a range of applications that are suited towards providing a mobile barber service.

(shortcut)The ability to offer a variety of services not limited to just a haircut or beardtrim.

1.4 Deciding on a Platform

1.4.1 Mobile vs Desktop

An important consideration in NPD is determining which platform best suits the project, mobile or desktop. Here, we will discuss the merits and pitfalls of each, before concluding which is most relevant for the project.

Market Share
Consumers are now for the first time viewing web pages on mobile devices at a higher rate than on desktop, at 54.8%, compared to just 31.16% in early

2015 [17]. Further to this, over the last year desktop usage has dropped from 46.39% to 41.36%, whilst mobile phone usage has increased from 50.88% to 55.89%, following on a several year long trend [6] that reflects a saturated mobile market driving down the cost of phones. However, this analysis is slightly premature due to only being indicative of the world market, whereas the proposed application will only operate within the United Kingdom. When we analyse just the U.K. data (figure 3) we see that the results are not so conclusive, with only a 0.97% difference between the two in favour of Desktop. Therefore a decision based entirely on market share is unfavourable and other metrics must be explored.

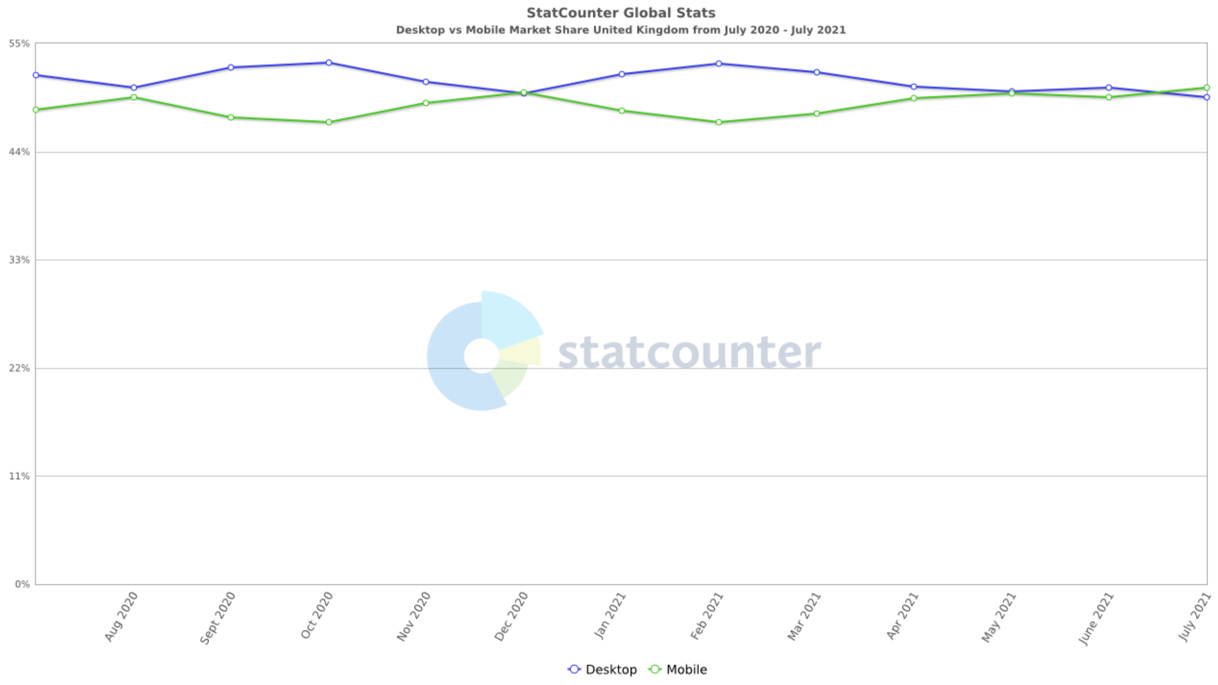


Figure 3: Desktop vs Mobile Market Share in the United Kingdom [5]

Features and Performance

Another metric to take into consideration is which features are required for the application and how this is reflected in mobile vs desktop applications. One the most pertinent features required is geolocation, which is much more suited to a mobile application due to inbuilt GPS. Another important consideration for the project is speed, for which mobiles perform actions much faster than a website. Finally, as continuation of the project to market is expected, speed of creation is essential, for which an application is better suited.

1.4.2 Mobile Platform: Android vs iOS

An important consideration when creating a mobile application is deciding on which platform to choose. The two largest mobile providers currently are android and apple (iOS). Historically, iOS has dominated the market share, with a 42.02% market share in January 2011 compared to Androids 12.42% (figure 4). Despite this, in recent years android OS has become more popular, even holding a greater share several times over the last few years and currently trails by only around 2%.

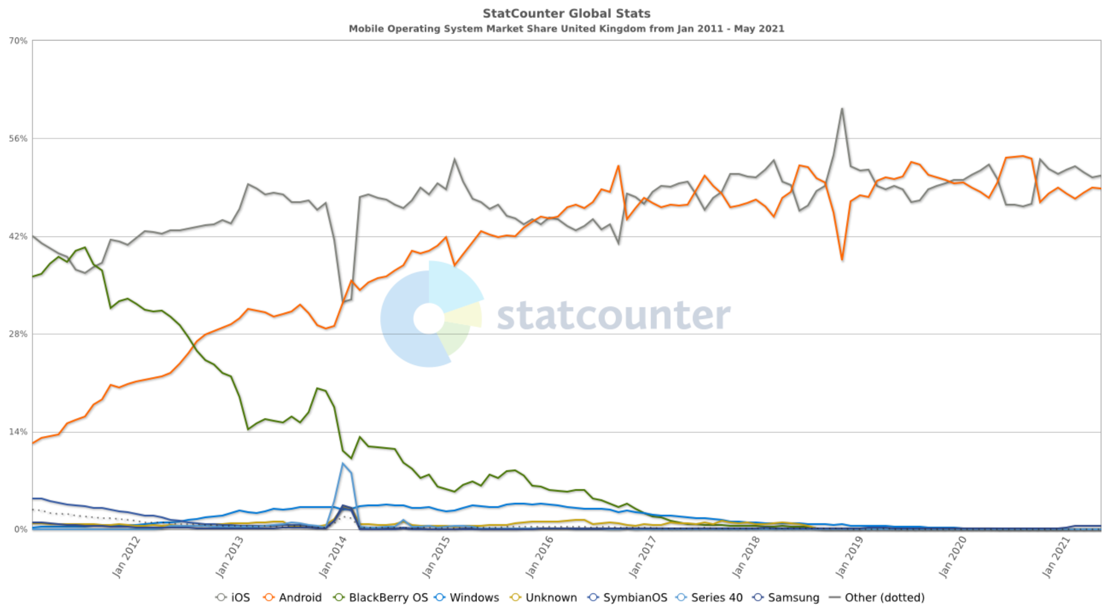


Figure 4: iOS vs Android Market Share Over The Last 10 Years [1]

With this change has brought with it a push towards frameworks that allow for development across multiple platforms, such as React Native ([22])

and Flutter ([11]). For this reason, it was decided that a cross platform framework would be used, which is further discussed below.

1.5 Frontend: Programming Language

When deciding on the programming software, several metrics were taken into consideration, including cross-platform functionality, speed, speed of development and performance. For this reason, Dart and the corresponding Flutter software development kit (SDK) were chosen for the primary software. Flutter is a cross-platform development kit, meaning that it will natively run on both iOS and android applications created by Google [11]. Dart is compiled ahead-of-time into native ARM code giving better performance compared to other similar development kits, such as React Native and the user interface is implemented within a fast, low-level C++ library giving great speed to the application. Dart has also seen a large increase in usage within recent years, jumping up 532% from 2018 to 2019 [27] meaning that there is now an extensible list of third-party plugins available and a large community.

1.6 Backend: SQL vs noSQL database

For the database, it was decided to use Google Firestore ([4]), a database that relies on nested 'documents' within 'collections'. This was chosen for several reasons. Firstly, as the chosen language 'Dart' is run by Google, using firestore allows for greater integration and congruence with the platform and APIs. Firestore also allows for rapid scalability, along with using Googles excellent cloud platform. The cloud firestore also integrates well with Firebases Authentication service, which is used throughout and discussed extensively in section 5

Another important feature of noSQL databases is the ability to easily modify the internal data in response to changing business requirements, in an interactive way that allows fordo you use relationship data in firebase stackoverflow modification throughout the application lifestyle and therefore easy scaling.

1.7 The Target User

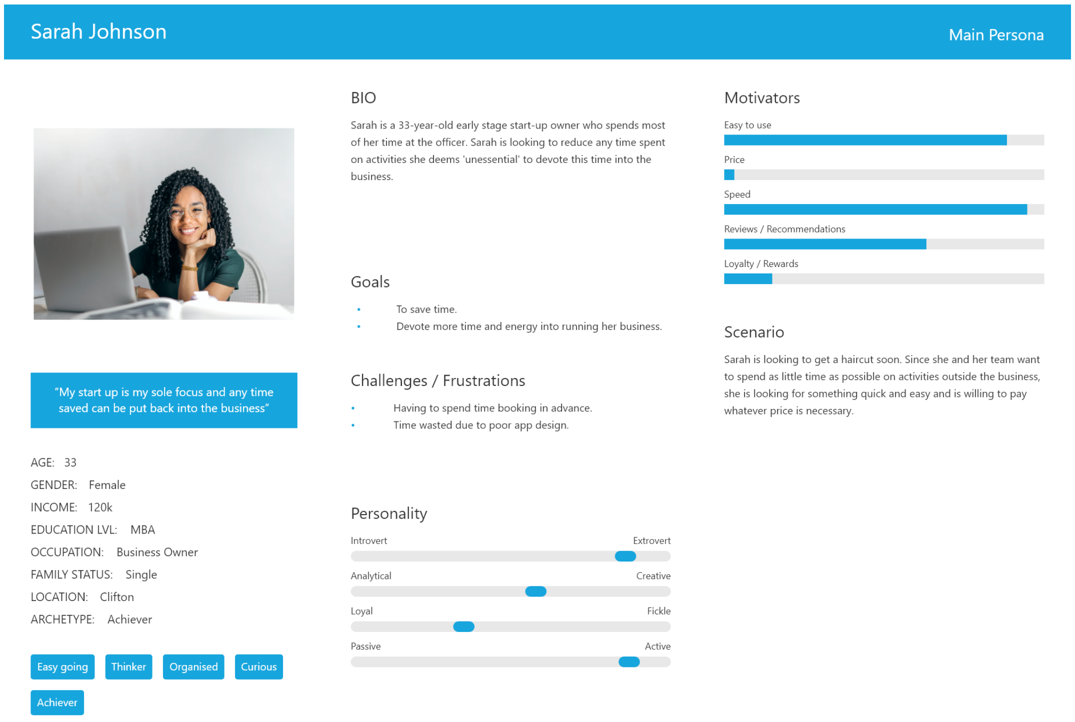
The planned application targets any user who wishes to get a haircut from their home. TODO: finish target user section

1.7.1 User Personas

The creation of user personas representing fictitious, archetypal users is an essential part of application development [19] and allows a deep understanding of the target user to be sought and implemented within the features and design of the application [2]. There are, however, some shortcomings to qualitative persona generation, such as validity concerns and user bias [3] and although they are addressed by other methods, such as data-driven personas [16], these require a broad user base and therefore we have decided to stick with qualitative methods, which allow for enough brevity and depth for the scope of the project.

Here 4 user personas were created, which are discussed in detail below.

<u>Persona 1 - Sarah Johnson</u>
Profile:


Sarah Johnson

Main Persona

"My start up is my sole focus and any time saved can be put back into the business"

AGE: 33
GENDER: Female
INCOME: 120k
EDUCATION LVL: MBA
OCCUPATION: Business Owner
FAMILY STATUS: Single
LOCATION: Clifton
ARCHETYPE: Achiever

Easy going · Thinker · Organised · Curious · Achiever

BIO

Sarah is a 33-year-old early stage start-up owner who spends most of her time at the officer. Sarah is looking to reduce any time spent on activities she deems 'unessential' to devote this time into the business.

Goals

- To save time.
- Devote more time and energy into running her business.

Challenges / Frustrations

- Having to spend time booking in advance.
- Time wasted due to poor app design.

Personality

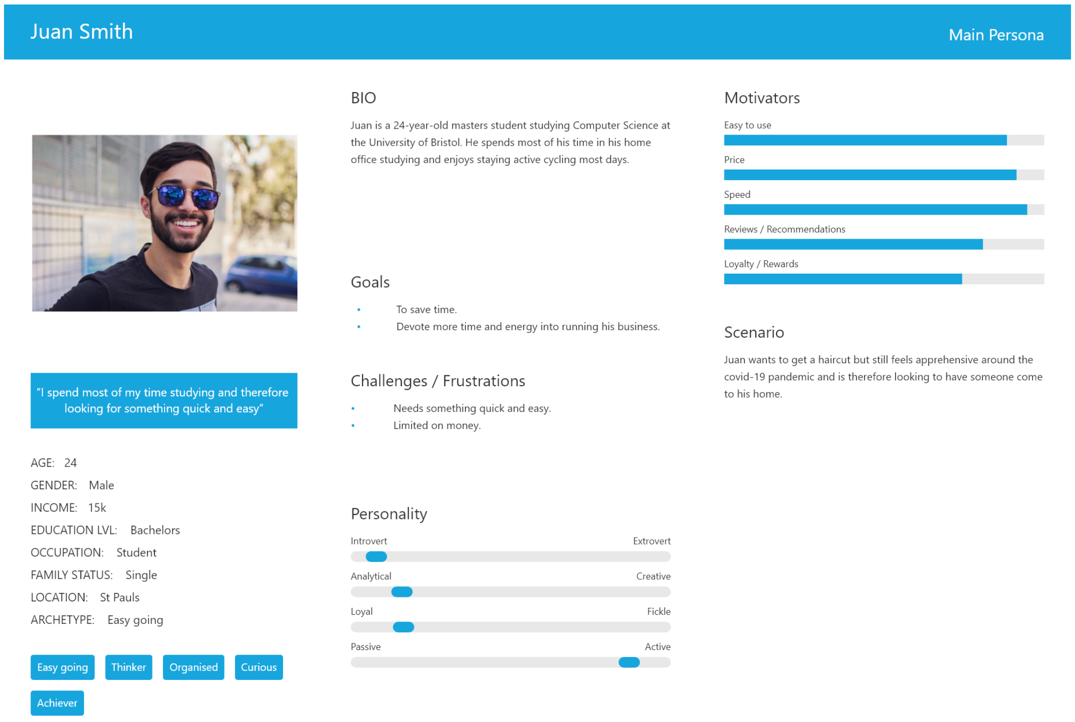
Motivators

Scenario

Sarah is looking to get a haircut soon. Since she and her team want to spend as little time as possible on activities outside the business, she is looking for something quick and easy and is willing to pay whatever price is necessary.

Figure 5: Persona 1

Persona 2 - Juan Smith
Profile:



Juan Smith

Main Persona

BIO

Juan is a 24-year-old masters student studying Computer Science at the University of Bristol. He spends most of his time in his home office studying and enjoys staying active cycling most days.

Goals

- To save time.
- Devote more time and energy into running his business.

Challenges / Frustrations

- Needs something quick and easy.
- Limited on money.

Personality

Motivators

Scenario

Juan wants to get a haircut but still feels apprehensive around the covid-19 pandemic and is therefore looking to have someone come to his home.

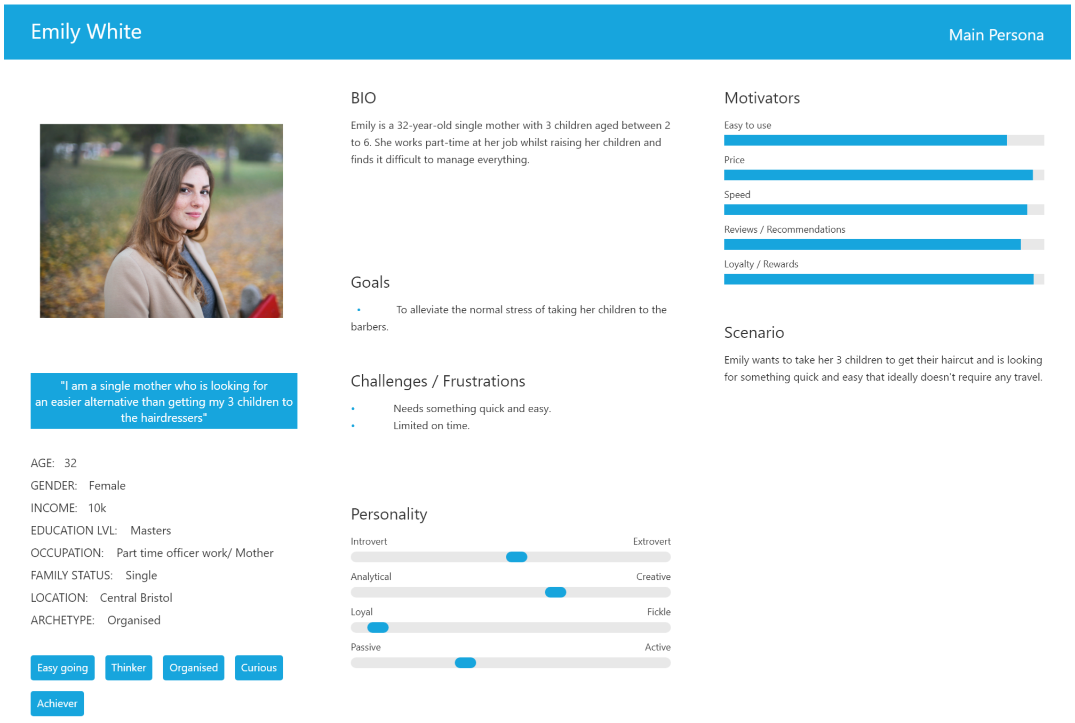
"I spend most of my time studying and therefore looking for something quick and easy"

AGE:	24
GENDER:	Male
INCOME:	15k
EDUCATION LVL:	Bachelors
OCCUPATION:	Student
FAMILY STATUS:	Single
LOCATION:	St Pauls
ARCHETYPE:	Easy going

Easy going Thinker Organised Curious Achiever

Figure 6: Persona 2

Persona 3 - Emily White
Profile:



Emily White

Main Persona

"I am a single mother who is looking for an easier alternative than getting my 3 children to the hairdressers"

AGE:	32
GENDER:	Female
INCOME:	10k
EDUCATION LVL:	Masters
OCCUPATION:	Part time officer work/ Mother
FAMILY STATUS:	Single
LOCATION:	Central Bristol
ARCHETYPE:	Organised

Easy going · Thinker · Organised · Curious · Achiever

BIO

Emily is a 32-year-old single mother with 3 children aged between 2 to 6. She works part-time at her job whilst raising her children and finds it difficult to manage everything.

Goals

- To alleviate the normal stress of taking her children to the barbers.

Challenges / Frustrations

- Needs something quick and easy.
- Limited on time.

Personality

Motivators

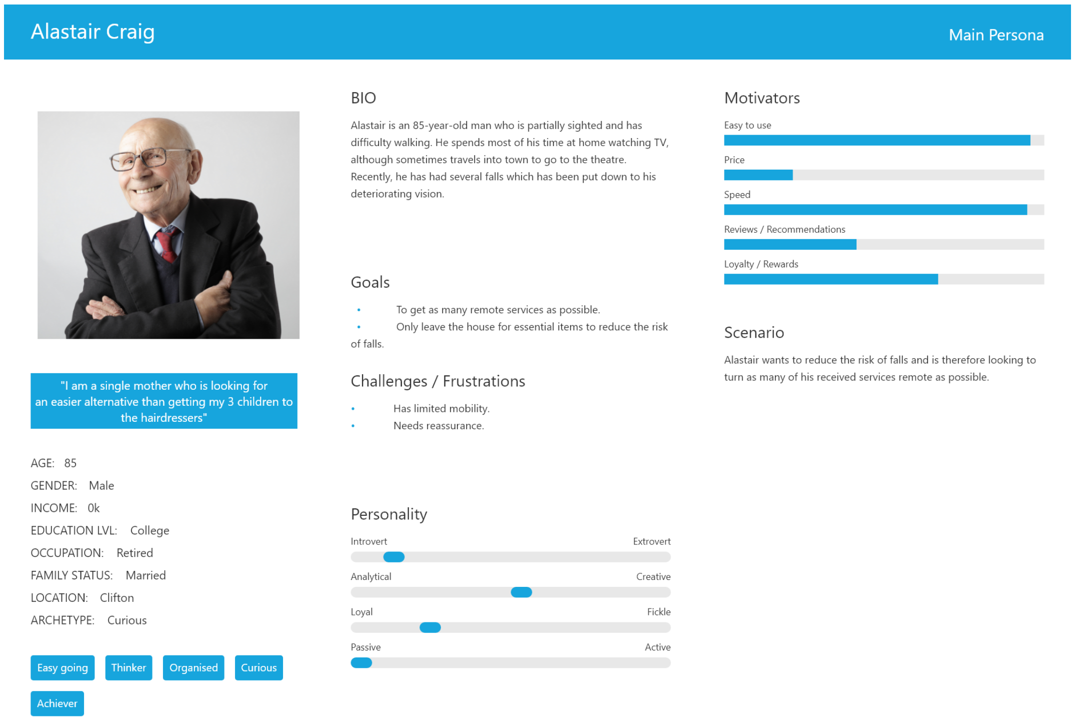
Scenario

Emily wants to take her 3 children to get their haircut and is looking for something quick and easy that ideally doesn't require any travel.

Figure 7: Persona 3

Persona 4 - Alastair Craig

Profile:



Alastair Craig

Main Persona

"I am a single mother who is looking for an easier alternative than getting my 3 children to the hairdressers"

AGE:	85
GENDER:	Male
INCOME:	0k
EDUCATION LVL:	College
OCCUPATION:	Retired
FAMILY STATUS:	Married
LOCATION:	Clifton
ARCHETYPE:	Curious

Easy going · Thinker · Organised · Curious · Achiever

BIO

Alastair is an 85-year-old man who is partially sighted and has difficulty walking. He spends most of his time at home watching TV, although sometimes travels into town to go to the theatre. Recently, he has had several falls which has been put down to his deteriorating vision.

Goals

- To get as many remote services as possible.
- Only leave the house for essential items to reduce the risk of falls.

Challenges / Frustrations

- Has limited mobility.
- Needs reassurance.

Personality

Motivators

Scenario

Alastair wants to reduce the risk of falls and is therefore looking to turn as many of his received services remote as possible.

Figure 8: Persona 4

2 Software Requirements

Here we discuss and outline the software requirements, for which this section is similar to that found within a software requirements specification (SRS) document and lays the framework for the entire project. Here we discuss the application scope, user needs, functional and non-functional requirements, along with use cases.

2.1 Application Scope

The scope of the project was to create a fully working and functional barber application with several features, which are discussed in the User Needs below. To further aid in scoping the project, epics were created, which were further split into stories that could be carried out. Although it could be argued that this type of agile methodology is more relevant when working within a team of developers, it helped to determine a stringent workflow and timeline and aided in project delivery. The scope was then further defined when wire-framing in Adobe XD, which allowed for the first tangible design to be made.

2.2 User Needs

- Allow the application to run on a mobile device.
- Allow the user to book a beauty treatment to receive at their home address.
- Allow a barber to set up an account and specify their product details.

2.3 Requirements

2.3.1 Functional Requirements

- Customer-side Application
  - The application shall allow a customer to create an account and login
  - The application shall provide the user with basic account management capabilities
  - The application shall allow for the user to pick from a range of relevant products and add them to their cart
  - The application shall allow the user full management of their shopping cart
  - The application shall provide only geographically relevant barbers and products to the user
  - The application shall allow the user to view their past orders
- Barber-side Application
  - The application shall allow a parent barber to create an account and login
  - The application shall allow for integrated back-end management of it's barbers and products
  - The application shall allow for the parent barber to view its orders

2.3.2 Non-Functional Requirements

- Performance
  - The application shall take no longer than 3 seconds to load the users home screen
- Data
  - The application shall cache data where possible
  - The application shall minimise calls to the database and make them only when relevant
- Use-ability
  - The application shall follow nielsen's usability heuristics and be easily usable for the user without any guidance or help
- Security
  - The application shall ensure that all app data be secured and encrypted
  - The application should use OAuth for access delegation
- Operating System
  - The application shall run on both iOS and android devices
  - The application shall run on all devices newer than android 5.0 (API 21) - around 94.1% of android devices
  - The application shall run on all devices newer than iOS 9.0 - around 99.6% of iOS devices

2.4 Use Cases

Here the use cases are presented, which are described by Ivar Jacobson as "a description of a set of sequences of actions and variants that a system performs that yield an observable result of value to an actor." (Jacobson, et. al., 1999, p.41). Use cases are useful in the sense that they provide a structure for collecting customer requirements and setting the scope [14]. They also allow for validation of the project through post-production testing, which can be seen in section section 6.

To produce the use cases we reference both the user personas created in subsubsection 1.7.1 and the functional and non-functional requirements discussed in the previous section. Below lists the most pertinent use cases.

- Use Case 1 - Sign Up
- Use Case 2 - Login
- Use Case 3 - Book a Haircut
- Use Case 4 - Search for a Barber
- Use Case 5 - Checkout
- Use Case 6 - View Orders
- Use Case 7 - Sign Out
- Use Case 8 - Add a Barber
- Use Case 9 - Add a Product

The above use cases are further designed in Appendix A.

3 System Design

In this section, we discuss the structure of the project, the system and software architectures and data and state management given the previously specified requirements.

3.1 Domain Model

TODO: discuss domain model Domain driven design (DDD), which originated from a 2003 book by Eric Evans [8] depicts a paradigm whereby data is visualised as a lexicon of abstractions, with the data model clearly representing key data concepts and the relationships between them. Modelling in this way bridges the gap between activities and interests of the users with the software and allows.

3.1.1 Entities

Within DDD it is recommended that a structured architecture is implemented, which is discussed in detail below.

TODO: continue with article and discuss how the project code was split using DDD, i.e. models, screens etc etc

3.2 System Architecture

https://www.raywenderlich.com/6373413-state-management-with-provider System Architecture can be broadly defined as a conceptual model which outlines the structure, behaviour and interactions between internal and external components of the system. Modelling and creating a structured and well-defined architecture allows for the development of a sustainable, scalable and stable software product which can easily grow relevant to the demands placed on it's features.

The overall system architecture can be seen below in figure 9.

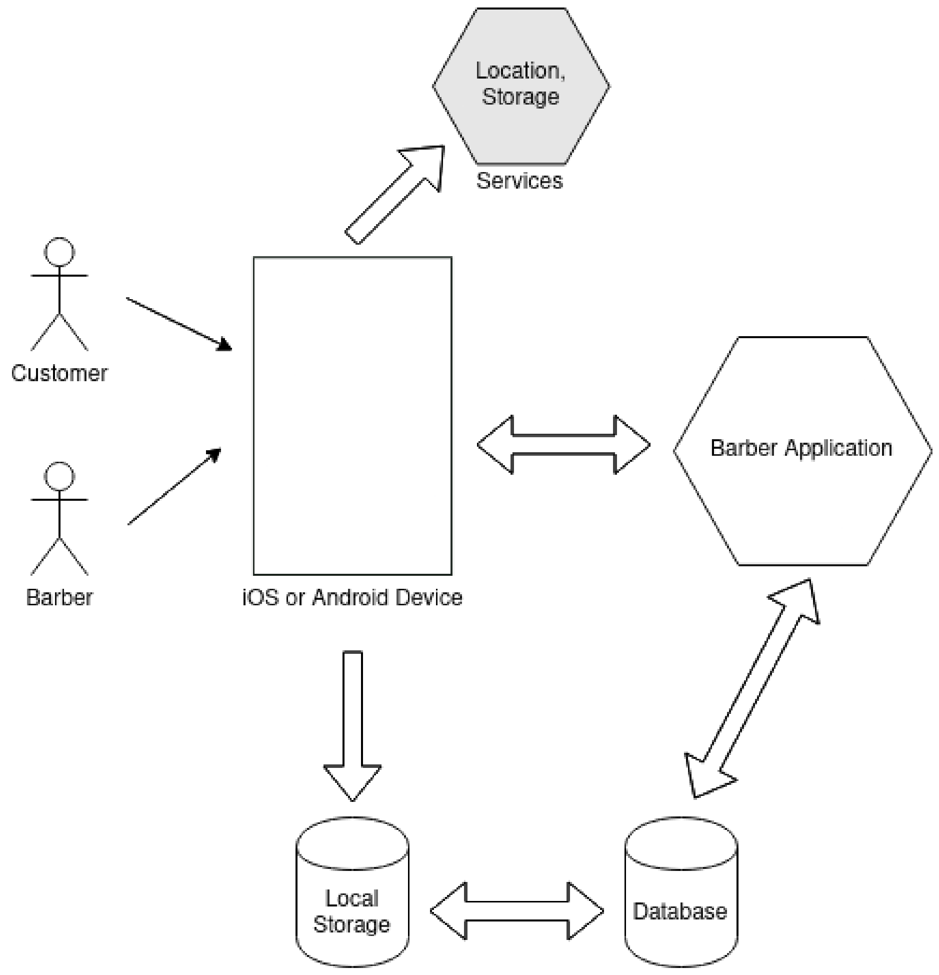


Figure 9: High-level System Architecture

When designing the architecture, core business logic was kept separate from the UI, database and network. For example, when interacting with the database the UI called upon the utilities package and any API calls where contained within the providers package. The project was also split into 3 layers, according to clean architecture principles ([15])

- Presentation layer
  - Screens - Contains unique UI elements
  - Widgets - Elements that are used to create the UI and feed into the screens

- Domain layer
  - Utilities - Contains business logic and elements that are used to make calls to the database or interact with any external APIs.
  - Providers - State management tools that are called on throughout the application.
- Data layer
  - Models - Contains the models used for local storage.

This generally follows clean architecture principles ([15]) and each layer is represented in figure 10 below.

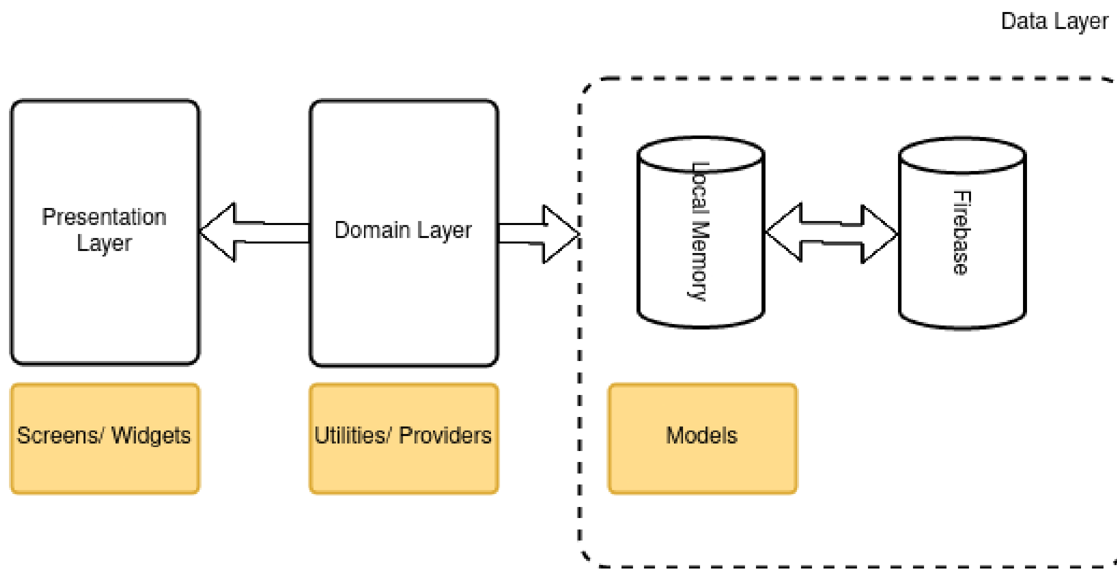


Figure 10: Clean Architecture (adapted from [15])

From this architecture and the previously devised specifications, an activity diagram was created, to detail the minimum required activities within the application, which can be seen in figure 11 below.

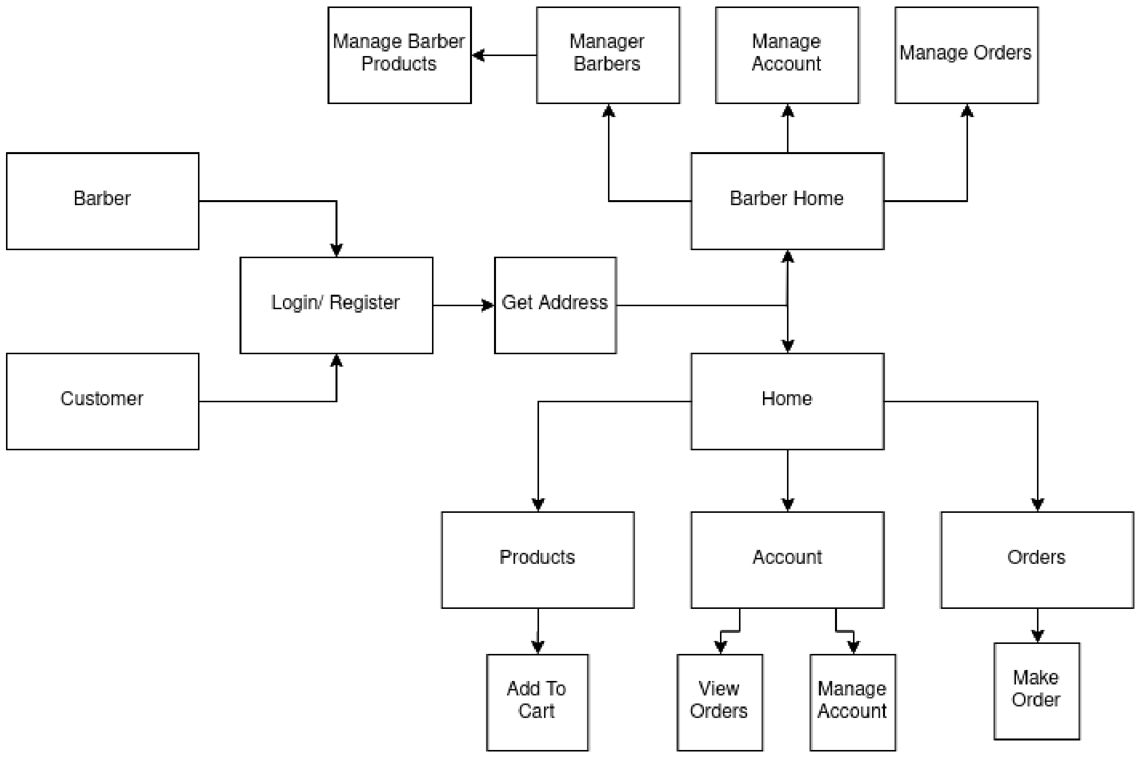


Figure 11: Application Minimal Activity Diagram

3.3 Client-side Specification

3.3.1 State Management

State management is an important feature within flutter. As flutter is declarative, rather than allow for changes in the widget or UI, each time a change is required the UI is rebuilt to reflect the applications current state. Within flutter there exists a variety of different methods for managing the state of the app, of which Provider, BLoC and GetX are some of the most popular and widely used. Here we will discuss the merits and pitfalls of each before settling on a framework for the application for both the local and global scope.

<u>Provider</u>
By far the most commonly used state management framework is Provider, a wrapper for the InheritedWidget class, which works by exposing all of the relevant daughter widgets to a value, so that data can be created, listened

to and disposed of globally. To do this, a class is first created that extends 'ChangeNotifier', which allows classes 'subscribe' to the senders data. Then, through using the method 'notifyListeners()' all of the daughter widgets will be updated with the current value and the UI rebuilt.

One negative of Provider is that it is only optimised for relatively few listeners, with it being $\mathcal{O}(n^2)$. With large applications and where speed is important this could be an issue.

BLoC

BLoC is a state management tool within flutter that is based on event driven states. For example, when adding to the basket you could trigger and AddBasketState, before checking out and triggering a CheckoutState. The benefit of this is that the code becomes fairly inflexible, which in a team working environment could reduce the risk of accidental bug implementation.

BLoC is also beneficial in acting to separate the logic from the widgets, which aligns with the previously discussed architecture principles.

GetX

A large benefit of GetX is that, unlike Provider and BLoC, it acts not only as a state management tool, but as a "micro framework". For example, one does not need to access the widget tree and context to navigate between routes, allowing for seamless navigation between pages and also finding the object anywhere using 'Get.find(), allowing for more separation between the business and presentation logic. Not needing to access context means that GetX also allows for dependency injection separate from using inheritedwidget, which removes unnecessary boiler plate code and aids in speed.

3.3.2 Provider

For locally managing state, 'setState()' can be utilised within a statefulWidget, which was used extensively throughout the project, for example in the Checkout screen when updating the total to match the given products.

For managing the global state within the project it was decided that Provider would be used as the primary global state management framework for several reasons. Firstly, it is fairly simple to understand, and when used with ChangeNotifier allows for the required state management for the proposed application. Secondly, Provider lends itself to a clean architecture with the logic seperated from the UI, meaning that a simple widget tree can be designed and implemented, which can be seen in figure 16 bellow, which displays the widget tree diagram for the application. Unlike BLoC, Provider allows for good flexibility, which as there was only 1 developer on the project makes more sense, giving greater scope for changes throughout the project. Despite this, future growth could lend itself towards also implementing BLoC alongside Provider, to improve structure and increase growth potential, a good example can be seen with Ebay's Motor App [26].

Finally, although GetX makes an excellent framework for larger projects, due to it's "micro framework" that encompasses several features not limited to controlling state management, the fairly simplistic nature of Provider better suited the relatively small project and hence was chosen here. The overall state management can be seen in the implementation section in 16.

3.3.3 Deciding on a Framework

There exists a variety of software architectural frameworks, although not exhaustive this includes Client-server, Peer-to-peer, Microservices and Model-view controller (MVC). For this project, we decided to go with MVC as the architectural framework, which, for brevity is the only discussed here. Used the screens as the view Used ChangeNotifier as the controller TODO: talk about MVC

4 Prototyping

An essential component of UCD and more generally UX design is prototyping, which involves making mock-ups of the application that act as early prototypes to influence later development [2]. Mobile app prototyping has many benefits to the project, including:

- Validates strategic design directions of the product
- Saves time by discovering any constraints early in the project
- Allows for early, interactive user testing
- Acts as a template for the UI during the implementation phase

The prototyping for the application involved two distinct stages; firstly, an initial sketch was done with pen and paper to discern the layout and overall themes associated with the app, before a wireframe was created to further define the prototype and allow for early testing.

4.1 Initial Sketches and Brainstorming

Initial sketches involve using pen and paper to elucidate problems and brain storm ideas for the project. During this phase, several design and UI features were considered, which allowed us to generate many ideas, using a fast and simple approach.

Some of these sketches can be seen in figure 12 below.

Figure 12: Pen and Paper Sketches and Brainstorming

(TODO: UPDATE PHOTO WITH INITIAL SKETCHES)

4.2 Wire-framing

Once the sketches were completed we moved on to wire-framing the application, which involved taking the best sketch variants and creating a more detailed, lower level prototype.For the wire-framing application Adobe XD was chosen for several reasons. Firstly, it has strong prototyping functionality, allowing the user to click around the application through the use of ‘components’. This interactivity means that early testers can get a real feel for how the application works. An illustration of this can be seen below, whereby each arrow represents a state change in the form of a trigger/ action pair, whereby for example a user could click on ‘Available Right Now’ and be taken to the ‘Checkout’ as seen in figure 13 below.

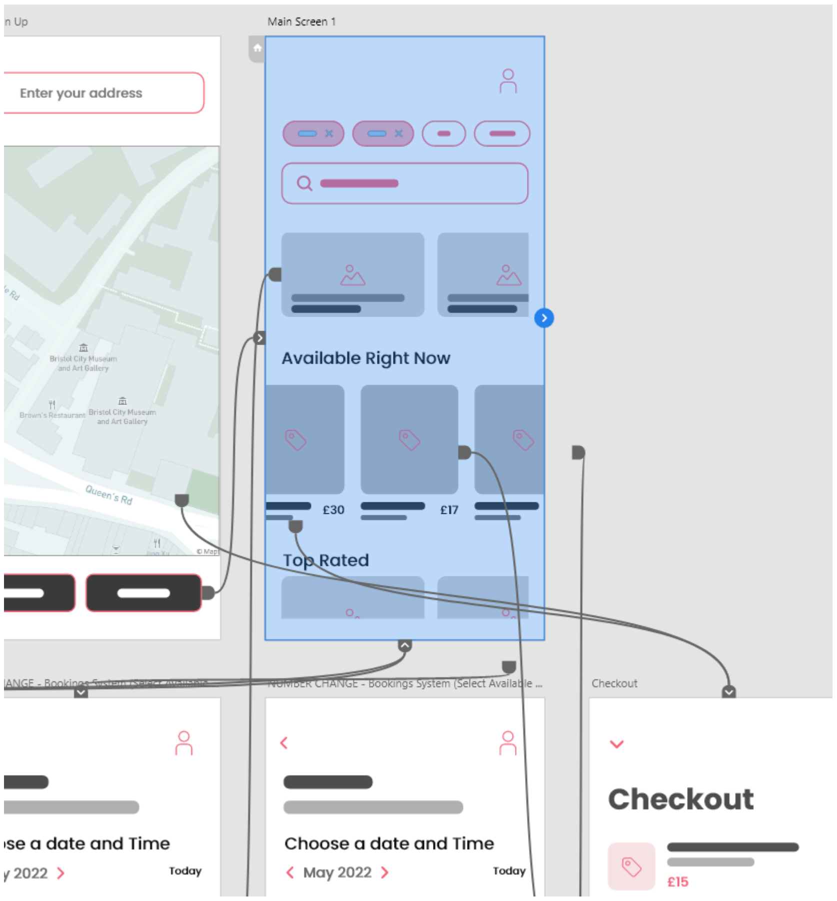


Figure 13: Component Interactivity within Adobe XD

Adobe XD also allows for easy distribution of the prototype in the form of a shareable link that opens in the browser and encompasses the same functionality and components that can be found within the application itself, meaning that anyone with access to a browser can test the prototype. Along with this, the prototype also allows for comments to be made, which are fed back to the owner. This comment capability was used early on during beta testing when it was sent out with the early questionnaire and influenced initial design decisions [25].

When designing the screens there was a strong focus on user experience following Nielsons 10 Heuristics for User Interface Design [9] . For example, the functionality was kept as minimal as possible to avoid clittering and avoid cognitive load on the user, the user was given control to go back and forward between previous screens to allow for user control and freedom and simple and self-explanatory language was used to apply recognition over recall. For example, the Sign In screen below extraneous text was kept to a minimum by using images for the login items, such as Google, Facebook and Twitter, a sign up button was included to allow the user to access the application through creating a new account and large, clear sign in forms and buttons were used. The full interactive Adobe XD wireframe can be found here.

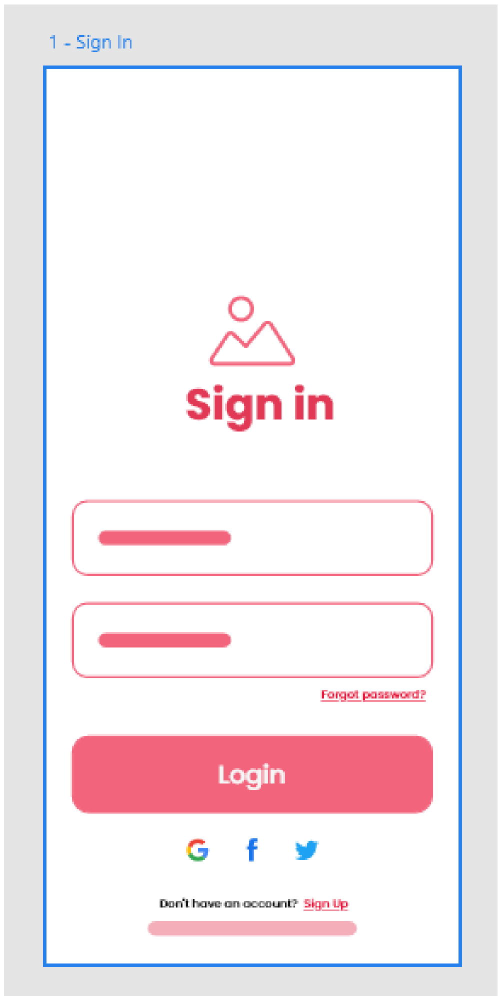


Figure 14: Sign In Page Made With Adobe XD

5 Implementation

Here we discuss the implementation of the application, which is divided into separate sprints, each of which pertains to a relevant feature within the application. Finally, we address the implementation each use case individually.

5.1 Setup

Before beginning the development sprints, the first task involved setting up the developer environment. To code the application it was decided that an integrated development environment (IDE) was used due to the comprehensive features it provides to aid in development and maximise productivity. For this, it was decided that the IDE 'Android Studio' by JetBrains [7] was to be used, due to previous experience and familiarity with other JetBrains applications, along with Android Studios excellent built in features and seamless integration with flutter.

5.1.1 File Structure

Although there is no official recommendation for structuring the app, here we follow a commonly used scheme which aligns with the previously discussed architecture principle and includes models; the files that serve as collections of data that are used in conjunction with the widgets to form the user interface of the application; providers, which inhabit the state management tools of the application; screens, which display the UI of the app; utilities, which are used to connect to the back-end; and widgets, which contain the business logic of the app.

5.2 Sprint 1 - UI

The first sprint involved implementing the UI, which was previously wireframed within Adove XD. Flutter offer an Adobe XD plugin to turn wireframes directly into code, however, this was not used for several reasons. In Adobe XD components are positioned absolutely, whereas in Flutter it is done relatively, leading to several issues with positioning that would not scale. Adobe XD also does not contain customer properties and therefore mapping these to components, such as title is not possible, therefore the UI was implemented manually.

Within Flutter, the UI is built through using widgets, which describe not only the look of the application, but also provide the state and can be rebuilt to reflect a change in state. As an example we can look at the forgot password screen, a segment of which is shown in D.2. The UI here is built using a variety of widgets. For example, line 2 shows a Column widget, which allows for daughter widgets to be stacked alongside each-other vertically. The first daughter widget is a TextField that allows us to get text from the user and this is wrapped within a padding widget, which allows us to specify the required padding to aid in UI design. Finally, a button is placed within the application using the GestureDetector widget, which, by implementing the 'onTap' function looks for input from the user and then navigates to the Login screen after using the AuthenticateProvider to send a password reset link.

5.2.1 Cupertino vs Material

A consideration when building the UI was on whether to model the application using Cupertino, which gives the app an iOS type look and feel or material, which is more generalised across android and iOS. As the project was designed to be multi-platform, it was decided that material would be used throughout.

Using material also lends itself well to the project for other reasons, For example, it gives us access to a number of useful widgets at the root of the application. For example, the Navigator allows us to keep a track of the users chosen screens as a stack and by using Navigator.pop() and Navigator.push() we can navigate between screens. This is implemented in the Navigate widget, which can be seen in appendix D.3 and allows us to easily navigate the user around the application. Using material also gives us access to both a bottom navigation bar, which can be seen in appendix D.5 and a side bar. Finally using material allows for easy styling of the app by using the built in class 'ThemeData'. The implementation of material can be seen in the main.dart file in appendix D.6 which serves as the root and entry point to the application.

5.3 Sprint 2 - Sign Up and Login

Once the UI was built the Login and Sign Up page logic was implemented. This involved creating an authentication page (aunthenticate.dart), which acted as a provider for the user and other authentication logic that could be injected into the UI along with using a database to store users so that user data could be persistent.

5.3.1 Authentication

Firebase has its own built in authentication library [10], which works by providing email and password based authentication along with OAuth 2.0 capabilities, both which were used extensively throughout. Firebase Authentication was used for the project due to several considerations -

- Excellent built in security features
  - Can easily restrict access to different specified groups within an organisation
  - Security is enforced by server-side rules, limiting unsafe usage within the app itself
  - Uses token generation to ensure confirmed data
- Integration with firebase database and storage
- Easy modification through Googles declarative language
- Excellent integration with OAuth 2.0
  - Using OAuth allowed for sign in methods with Google, Facebook and Twitter to align with the previously drawn wireframes
- 99.999% SLA

5.3.2 Sign Up

The user is first presented with the sign up screen whereby they can enter their name, email and password and click through to make an account. Once the user clicks the Sign Up button, a token is created within Firebase Authentication and the credentials are stored. Inside of authenticate.dart there is a signUp method which carries out the logic behind user sign up, which works in several steps.

- First, a UserCredential (which holds the return value of firebases sign up method) is returned from an attempt to create a new user with the email and password

- Next, a created model (UserModel, which can be seen in appendix D.7) is assigned to the user which holds all pertinent information, such as name, email, shopping cart items etc

- The Authenticate enum status is set to AUTHENTICATED as discussed below

5.3.3 Login

Once the user has been created and the credentials are stored, the user can login using the given name and password. This is then authenticated with Firebase and a response is returned to the client, before the user is then logged in for the session. To follow the authentication status of the application we created an enum seen in figure 5.3.3 below. This can then be tracked by using 'Provider.of¡AuthenticateProvider¿(context)', allowing us to manage and alter the state of the application based on the status of the user.

```
enum AuthStatus {
  UNINITIALISED,
  UNAUTHORISED_USER,
  UNAUTHORISED_BARBER,
  NOT_AUTHENTICATED,
  AUTHENTICATING,
  AUTHENTICATED,
  BARBER_AUTHENTICATED,
  AUTH_WITH_MAPS
}
```

Figure 15: AuthStatus Enum Found in authenticate.dart

The user can also be authenticated and signed in using Google sign in; for which the 'google_sign_in' package was utilised, Twitter sign in; for which the package flutter_twitter_login was used and Facebook sign in; whereby the package flutter_facebook_auth was used. All of these work by returning a respective OAuth token and therefore is a secure way to authenticate the user.

Similar to when signing up, on login, a User Model is created, which locally stores the details needed for the user, i.e. id, name, email, address and any other relevant data such as their cart items within the Authenticate class. In this way, the data contained within can be accessed using Provider and data such as cart items accessed globally. Part of the user model can be seen in appendix D.7.

5.3.4 State Management

As previously discussed, flutters built in Provider was used for the state management required throughout the application. As seen in figure 16 - which displays a widget tree diagram for the application, two providers, AuthenticateProvider and ParentBarbersFirestore are passed down the chain and are used to access relevant variables and data types globally. Within Authenticate provider the current user is stored, therefore giving access to their details, along with previous orders and current shopping cart items. Due to flutters declarative nature, this means that the state is kept above the widgets currently using it.

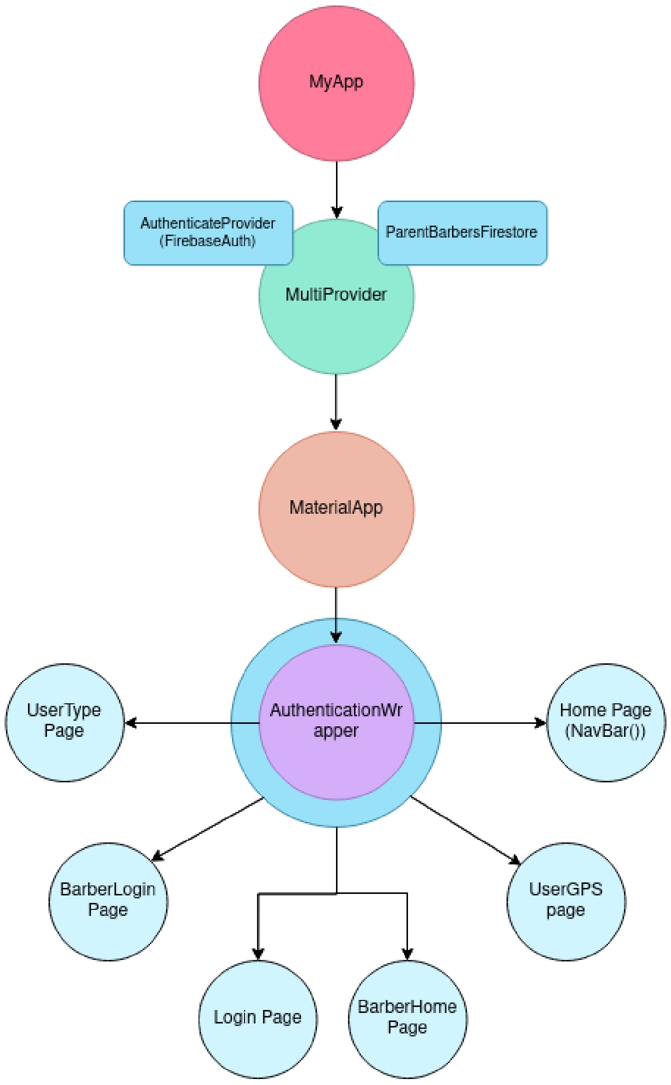


Figure 16: Widget Tree Diagram

5.4 Sprint 3 - Backend Setup and Modelling

The next sprint involved modelling and creating the database to suit the needs of the project. As previously discussed, it was decided that a noSQL database, instead of a relational one was to be implemented due to the aforementioned benefits it provided.

5.4.1 Setup

The setup for firebase was simple and involved several steps. First a project was created, initialised and registered on firebase.google.com. Next, the plugin 'cloud_firestore' was installed with flutters built in 'pub get' function. For security, firebase has it's own language that allows us to implement rules that regulate access for both reading and writing to the database. This works by the given rules pattern matching against database paths, so for example in our database, if we only wanted to give read and write access to the /users paths to logged in users we would write

```
...
  "users": {
    "$uid": {
      allow read, write:
      if "auth.uid == $uid"
    ...
```

As the project was only to show proof of concept it was decided that, rather than specify specific rules, only authenticated users could gain access to the entirety of the database. This is shown below, which displays code giving the user access to any documents within the database so long as they are logged in.

```
  service cloud.firestore {
    match /databases/{database}/documents {
      match /{document=**} {
        allow read, write:
        if auth != null
      }
    }
  }
```

5.4.2 Database Design

Although noSQL is most frequently used for non-relational data a database schema was constructed to constitute the parent barbers, barbers, users, orders and products as modelling this way added to readability with the added benefit of the features previously discussed. The schema is represented in figure 17 below and shows each class with a primary key and foreign key where necessary.

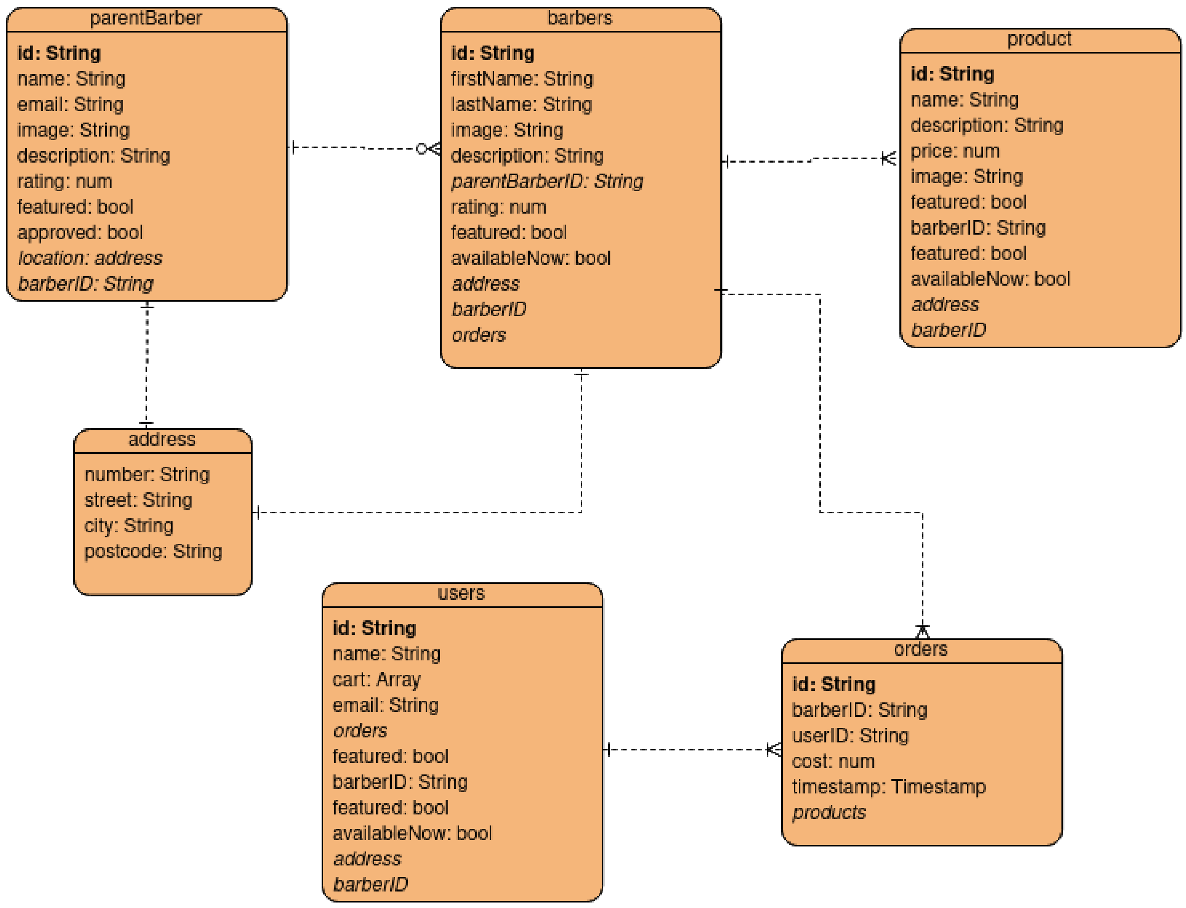


Figure 17: Database Schema

5.4.3 Creating the Models

As previously mentioned, within the project we used models to represent the data layer within our architectural structure. These were portrayed as individual classes, each of which contained minimal, only necessary logic relevant to it's inherent functions. This is shown in figure 18 below, which shows the model class diagrams and their relationships.

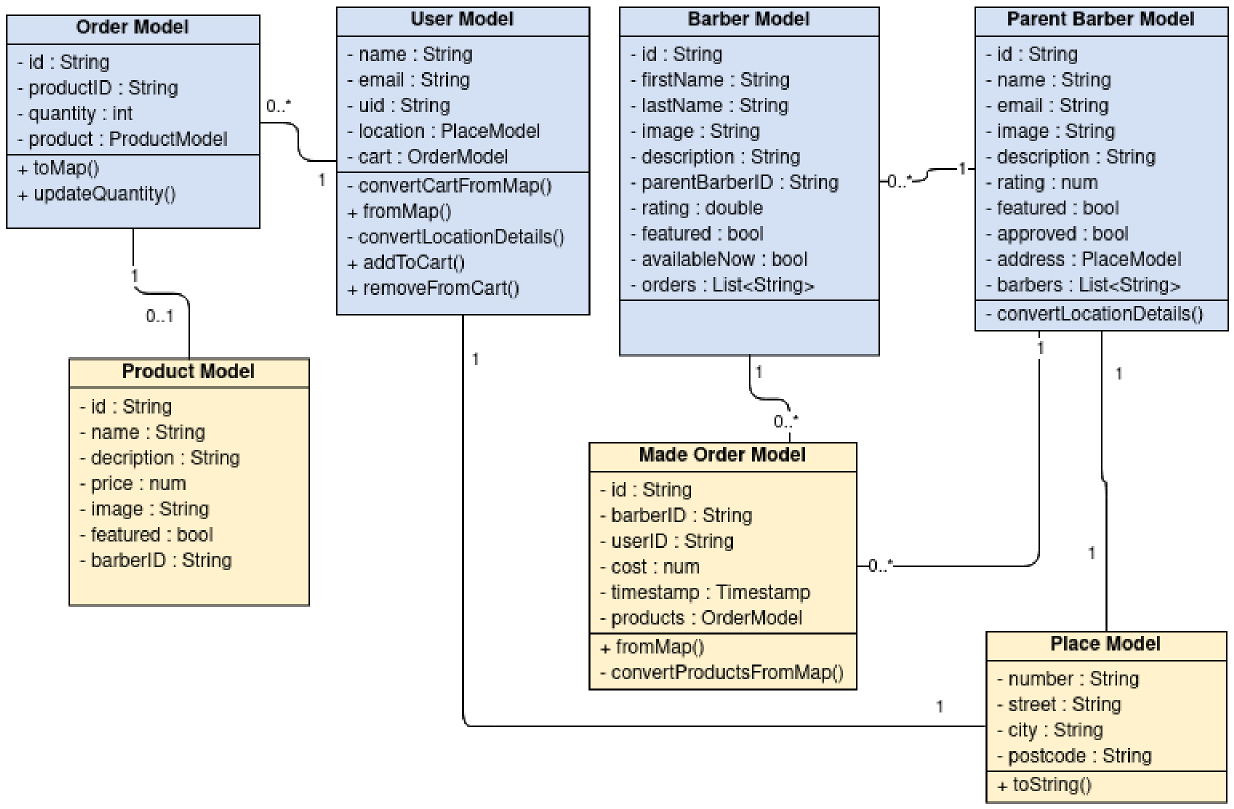


Figure 18: Model Class Diagrams

TODO: remove bottom but of barber model class

Each model also contains a ".fromSnapshot" function. DocumentSnapshots are data containers that hold undefined documents from firebase. To access this, we make a call using a CollectionReference, which is simply a reference to the data location within firebase, before defining the incoming data and specifiying its type. Having a .fromSnapshot function within each model allows us to simply call the function on the DocumentSnapshot to explicitly define the data type and then load it into memory.

5.4.4 Avoiding Nested Data

A consideration when creating the database was to optimise queries for fast lookup time, as this was one of the main considerations in choosing a noSQL over SQL database. For this reason, when storing data, the id was stored as the document id. For example within the UserFirebase class, for the 'createNewUser()' function, we pass through the authentication uid, which is then used as the document id. This means that rather than querying with a call such as

```
    _firebaseFirestore.collection(collection).where
      ('uid', .isEqualTo('givenID')).get()
```

which does not scale well due to a search time of $\mathcal{O}(n)$. Instead, we store the uid as the document id, allowing us to do a similar, although quicker call such as

```
    _firebaseFirestore.collection(collection).doc(
      userId).get()
```

which gives a search time of $\mathcal{O}(1)$.

5.5 Sprint 4 - Connecting the Frontend and Backend

Now that we have built a frontend UI, the database has been created, along with models to locally store data, it is time to connect the two.

5.5.1 Loading the Parent Barbers

After the user is logged in they are presented with the main screen containing 3 seperate widgets; Featured(), which presents the user with 2 parent barbers; AvailableNow(), which shows a list of the barbers that are immediately available; and TopRated(), which displays a column of the 5 most top rated parent barbers. Each of the 3 elements is contained within it's own widget as per the previously discussed clean architecture principles. All of the logic that connects the frontend and backend are placed inside of the utilities folder, which acts as the controller within the MVC or domain layer of our architecture.

When loading the parent barbers, initially this was done with 3 separate calls to the server. An example of this is when getting the parent barbers for the topRated() widget, the following database query was made:

```
    _firebaseFirestore.collection("parentBarber").
      orderBy("rating", Direction.DESCENDING).limit
      (5).get();
```

This made a call to the collection parentBarber, ordered by the top 5 rated parent barbers and fetched the resulting data. As there were 3 different widgets this resulted in 3 separate calls to the database. This was later changed in favour of fetching all of the parent barbers first before filtering within memory. This aided in not only increasing speeds due to local filtering, but also reduced the number of needed calls to the database, further reducing speeds and costs. An example of this filtering can be seen in the 'filter-list.dart' file in appendix D.4.

This is done in the body of the 'parent_barbers.dart' class and therefore is run when the class is instantiated. This is run in 'main.dart' using a 'ChangeNotifierProvider' as shown below and therefore means that the data is loaded as soon as the application is run and can also be accessed globally throughout the application along with the descendents being updated and rebuilt with any change in the widget.

```
...
ChangeNotifierProvider<ParentBarbersProvider>(
create: (_) => ParentBarbersProvider(),
),
...
```

Note: Loading the parents also involved filtering via location, which is discussed in detail in section 5.6.

5.5.2 Loading the barbers

Once the parent barbers are loaded we must now load the individual barbers, each of which have 1 parent barber. This can be done in two ways; either through making a database query based on the parent barber ID and fetching only the relevant barbers for each parent barber loaded in memory, or through loading every available barber into memory and then filtering in situ. Each method comes with pros and cons which are discussed briefly below.

<u>Database Call on Parent Barber ID</u>
As previously mentioned, firebase has a lookup time of $\mathcal{O}(1)$, therefore making individual calls to the database will scale well as it does not matter how

many barbers there are within the system. Another benefit is that only the relevant barbers will be loaded into local memory, saving on valuable space. The disadvantageous side to this method of fetching the barbers, is that it will require several database calls, depending on how many parent barbers there are and therefore add to costs.

Loading all Barbers and Filtering Locally

Loading all the barbers and filtering locally is beneficial in that it is cheaper due to less database queries, however, the negative is that it does not scale well, due to having to load more and more barbers as the application grows. However, as further discussed in section 5.6, we filter first based on location and therefore greatly limit the amount of relevant barbers.

5.5.3 Loading the users orders

5.5.4 Shopping Cart

Chose to store the cart items in a nested array as this adds to readbility and structure and although this restricts look up time, this is not relevant due to the limited number of items a user will order.

5.5.5 Checkout

Similar to section 5.3.1 to create a search time of $\mathcal{O}(1)$ a seperate 'orders' collection was created, with each document representing all of the pertinent order details. Within each barber and user, the document (order) id was then added to each respective order arrays, for quick and easy lookup.

5.6 Sprint 5 - Location

https://firebase.google.com/docs/firestore/solutions/geoqueries Once the user logs in they give their location in the form of their address. This is stored in 'geohashes', which are longitude and latitiude co-ordinates that are hashed into a single Base32 string. Each character presents a greater level of precision and therefore we opted for 9, which represents an area of 5 x 5 meters.

User location access is granted through the following line in the ./android/app/src/main/AndroidManifest.xml file

```
    <uses-permission android:name="android.
       permission.ACCESS_FINE_LOCATION"/>
```

For the search results we use a drop down menu in the form of flutters built in 'showSearch' function loosely following a guide on medium [23] to display a search page and 'SearchDelegate' to define the content of said search page.

A textEditingController is used to collect the inputted data from the user and pass through to the showSearch function.

5.6.1 Autocomplete locations

As a means for the user to autocomplete their address when signing up, the 'Place Autocomplete service' within the Google Places API, which returns location predictions in response to HTTP requests was implemented using a request adhering to a set of parameters, the full list, along with details of the API can be found on the Google Developers website [20]. First, we enable the Places API within the Google console, before we then create a location model which can hold the data returned from the API. We then create an API request using the above aforementioned API format. For brevity, not every option is discussed, but those of importance include 'input', which is the user query, 'types', which determines the query returned, for which we specify address as we wish to fetch the users full address and a session token, which is required for each new query. The query can be seen here:

```
    'https://maps.googleapis.com/maps/api/place/
       autocomplete/json?input=$input&types=address&
       components=country:uk&lang=en&key=$apiKey&
       sessiontoken=$sessionToken'
```

The returned results are in json format and after some minor error checking we parse using json.decode into a list with our LocationModel class, whilst assigning a new UUID for each query (Google recommends to use version 4 UUID and so this is used here). Without our 'user_gps.dart' file

For the content of the search page we use pass in newly created session token into the ShowSearchPage class, which in turn sends an API request and parses the json data to return a list of locations in the form of 'place id's' and 'description' using a FutureBuilder. From here, we pass through the location id to the getLocationDetails function to fetch the address details of each location and put into a PlaceModel object.

Next, we parse the data into JSON format by passing the PlaceModel object into the function 'createLocationMap', which creates a map using the location data. Finally we pass through this map to the 'addLocationDetails', which uses the given user id to update the database with the users location.

5.7 Sprint 6 - Barber Side Application

The next sprint involved.. In order to create a comprehensive application the final sprint involved coding a barber side app, giving the ability for the barber interact with the database and allow them to create an account, add and remove barbers and view orders.

5.7.1 Creating a Parent Barber

As the location functionality of the application requires both longitude and latitude co-ordinates, along with a geohash (EXPLAIN HOW PLUGIN USED TO GET THIS).

5.7.2 Loading the barbers orders

Each barber has a list of order ID's from previously made orders. To display the list of parent barbers orders first we fetch each barber ID from the array of barber ID's within the parent barber. Next we fetch the order ID's for each barber.

5.8 Widgets, Common Items and Added Features

Here we discuss any items not covered within a specified sprint.

5.8.1 Widgets

Several widgets were used to increase readability and brevity of code. For example, 'return_text.dart' allows for access to the main components of the Text function and 'return_image.dart' allows for easy use of the NetworkImage function, giving brevity and readability to the code.

5.8.2 Common Items

The common items contains global variables that were accessible throughout the project. Initially this included structures and arrays that served as objects to test the functionality of the frontend, for example a barber shop class with a nested list of barbers classes, each with a name, age, description etc. As backend functionality was added these items were removed. A theme class was then added which contains dart files that can be implemented. Doing it in this way meant that the application could be easily styled, without any unnecessary refactoring of code.

5.8.3 Launcher Icons

Created using GIMP. Plugin flutter_launcher_icons used to install icons across android and iOS

5.8.4 Discount Codes

5.8.5 Hide and Show Password

6 Testing

6.1 User Testing

6.2 Acceptance Testing

[12] It is recommended that acceptance testing is used throughout development as a metric to ensure a continious link between the customer and development and is an important tool within UCD. To implement this, here we analyse against the previously defined use cases as set out below.

6.3 Use Cases

TODO: refer to screenshots of app in use cases

7 Conclusion and Further Work

7.1 Conclusion

The motivation for this project was to create a cross-platform working MVP of a delivery barber app that attained the required objectives as stated in the introductory chapter, which are addressed here.

<u>Conduct Research to elucidate any market gaps</u>

I begin the thesis by discussing the methodologies that will be utilised throughout the project, for example new product development - which encompassed the stages involved to bring the app from ideation to market and agile software development, which was used as a more general project management tool to guide the work. In section 1.3 I then go on to discuss existing applications in the field, any market gaps and characterise the novelty of the proposed application. I therefore believe that this first objective was met well.

<u>Through a user centric design methodology plan and prototype the user interface of the application</u>

After discussing market gaps I then go on to decide which platform best suits the application, which can be seen in section 1.4, where I also discuss the most suitable software modalities, including frontend and back-end platforms. I then move on to presenting the target user and the conception of user personas, an integral component of UCD. The next chapter I present as a software requirements specification document, outlining the scope, user needs and requirements of the application, along with any pertinent use cases. Although I believe I met the minimum requirements for a user centric design approach, I feel this could have been further improved through iterative development of further MVPs and regular user testing, as this was only carried out during the early and late stages of development.

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Appendices

A Use Cases

A.1 Use case 1 - Sign Up

Use Case 1	**Sign Up**
Description	*Allow the user to sign up and create an account*
Pre-conditions	The user must not be signed in
Basic Flow	1a) The user enters their sign-up details 1b) The user clicks on one of the OAuth sign-in buttons 2) The system creates and authenticates the new user and signs them in 3) The user is signed-in
Alternative Paths	1) The user enters an email address in use and is notified of this 2) The user enters an invalid password or email and is notified of this

A.2 Use case 2 - Login

Use Case 2	**Login**
Description	*Allow the user login*
Pre-conditions	The user must be signed in
Basic Flow	1a) The user enters their login details 1b) The user clicks on one of the OAuth sign-in buttons 2) The system validates the authentication request 3) The user is signed-in
Alternative Paths	1) The user enters the wrong login details and is notified of this

A.3 Use case 3 - Book a Haircut

Use Case 3	**Book a Haircut**
Description	*Allow the user to book a remote haircut*
Pre-conditions	The user must be signed in
Basic Flow	1) The customer navigates to the required product 2) The customer chooses the required quantity and clicks 'Add To Cart' 3) The system adds the item to the users cart 4) The user is taken to the Home Screen
Alternative Paths	1) The user tries to add a product already in the basket and is unable to

A.4 Use case 4 - Search for a Barber

Use Case 4	**Search for a Barber**
Description	*Allow the user to enter a search term to find a relevant barber*
Pre-conditions	The user must be signed in
Basic Flow	1) The customer enters a search term within the search bar on the 'Home' screen 2) The system presents the user with a list of relevant barbers
Alternative Paths	none

A.5 Use case 5 - Checkout

Use Case 5	**Checkout**
Description	*Allow the user to checkout their basket and create an order*
Pre-conditions	The user must have items in their basket
Basic Flow	1) The user requests to checkout their basket 2) The system creates and authenticates the new user and signs them in
Alternative Paths	1) The user does not have any items in their basket and is notified of this

A.6 Use case 6 - View Orders

Use Case 6	**View Orders**
Description	*Allow the user to view their placed or confirmed orders*
Pre-conditions	The customer must have made an order or the barber must have customers orders
Basic Flow	1) The user requests to see their orders 2) The system fetches them and displays them to the user
Alternative Paths	1) The user does not have any orders and is notified of this

A.7 Use case 7 - Sign Out

Use Case 7	**Sign Out**
Description	*Allow the user to sign out of their account*
Pre-conditions	The customer must be signed in
Basic Flow	1) The user requests to sign out 2) The system signs out the user
Alternative Paths	none

A.8 Use case 8 - Add a Barber (*barbers only*)

Use Case 8	**Add a barber**
Description	*Allow the parent barber to add a new barber*
Pre-conditions	None
Basic Flow	1) The parent barber enters the details of the barber 2) The parent barber requests to create a new barber with the given details 3) A new barber is created
Alternative Paths	none

A.9 Use case 9 - Add a Product (*barbers only*)

Use Case 9	**Add a product**
Description	*Allow the parent barber to add a new product*
Pre-conditions	There must be a barber to add the product to
Basic Flow	1) The parent barber enters the details of the product 2) The parent barber assigns the product to a barber 3) The parent barber requests for the product to be created 4) The system creates a new product and assigns it to the barber
Alternative Paths	none

B Figures

C Application Images

D Code Snippets

D.1 Partial Code for Authenticate.dart Showing the Email and Password Sign In

```dart
Future<bool> signIn({String email, String password}) async {
  try {
    _authStatus = AuthStatus.AUTHENTICATING;
    notifyListeners();
    final UserCredential _authResult = await
    _firebaseAuth.signInWithEmailAndPassword(email: email,
    password: password);
    print("signed in " + email);
    userModel = await
    _orderUtility.getUserById(_firebaseAuth.currentUser.uid);
    List<OrderModel> orders = [];
    orders = await _orderUtility
    .getDatabaseCartItems(_authResult.user.uid);
    userModel.cart = orders;
    _authStatus = AuthStatus.AUTH_WITH_MAPS;
    notifyListeners();
    return true;
  } on FirebaseAuthException catch (e) {
    print(e);
    _authStatus = AuthStatus.NOT_AUTHENTICATED;
    notifyListeners();
    return false;
  }
}
```

D.2 Partial Code for forgot_password.dart

```
    Container(
      child: Column(
        children: [
          Padding(
            padding: const EdgeInsets.fromLTRB(40, 30, 40, 0),
              child: TextField(
                controller: emailController,
                decoration: InputDecoration(
                labelText: "Email",
              )
            ),
          ),
      Padding(
        padding: const EdgeInsets.fromLTRB(35, 40, 35, 0),
        child: SizedBox(
        height: 70,
        child: Material(
          borderRadius: BorderRadius.circular(15),
          shadowColor: theme,
          color: theme,
          child: GestureDetector(
            onTap: () {
              context.read<AuthenticateProvider>().resetPassword(
              emailController.text.trim()
            );
            navigateToScreen(context, Login());
          },
          child: Center(
            child: ReturnText(text: 'Send Reset Link', fontWeight:
            FontWeight.w500, size: 30, color: white,),
            ),
          ),
        ),
      ),
    ),
```

D.3 Code for navigate.dart

```
  import 'package:flutter/material.dart';

```

```
// Bidirectional screen navigation
void navigateToScreen(BuildContext context, Widget widget) {
  Navigator.push(context, MaterialPageRoute(builder: (context)
  => widget)
  );
}

// One way screen replacement
void replaceScreen(BuildContext context, Widget widget) {
  Navigator.pushReplacement(context, MaterialPageRoute(builder:
  (context) => widget)
  );
}
```

D.4 Code for filter-list.dart

```
  class FilterList {

    // Order by highest rated and return the top 5
    Future<List<ParentBarberModel>> getTopRatedParents(List<Parent
    BarberModel> parents) async {
      parents.sort((a, b) => b.rating.compareTo(a.rating));
      return parents.take(5).toList();
    }

    // Find the featured parents, although this should always
    // only be 2, filter just in case
    Future<List<ParentBarberModel>> getFeaturedParents(List<Parent
    BarberModel> parents) async =>
    parents.where((element) => element.featured == true).take(2)
    .toList();

  }
```

D.5 Code for navigation_bar.dart

```dart
class NavBar extends StatefulWidget {
  @override
  _NavBarState createState() => _NavBarState();
}

class _NavBarState extends State<NavBar> {
  int _currentIndex = 0;
  List<Widget> _pages = <Widget>[
  Home(),
  Account(),
  UserOrders(),
  ];

  void _onItemTap(int index) {
    setState(() {
      _currentIndex = index;
    });
  }

  @override
  Widget build(BuildContext context) {
    return Scaffold(
      body: Center(
        child: _pages.elementAt(_currentIndex),
      ),
      bottomNavigationBar: BottomNavigationBar(
        currentIndex: _currentIndex,
        items: const <BottomNavigationBarItem>[
          BottomNavigationBarItem(
            icon: Icon(Icons.home),
            label: 'Home',
          ),
          BottomNavigationBarItem(
            icon: Icon(Icons.account_box_rounded),
            label: 'My Account',
            ),
          BottomNavigationBarItem(
            icon: Icon(Icons.shopping_basket),
            label: 'My Orders',
          ),
        ],
        onTap: (index) {
          setState(() {
            _currentIndex = index;
            });
          },
        )
      );
    }
  }
```

D.6 Partial Code for main.dart

```
class MyApp extends StatelessWidget {
  // This widget is the root of your application.
  @override
  Widget build(BuildContext context) {
    return MultiProvider(
      providers: [
        ListenableProvider<AuthenticateProvider>(
          create: (_) => AuthenticateProvider(FirebaseAuth.instance),
        ),
        StreamProvider(
          create: (context) =>
          context.read<AuthenticateProvider>().stateChanges,
          initialData: null,
        ),
        ListenableProvider<ParentBarbersProvider>(
          create: (_) => ParentBarbersProvider(),
        ),
      ],
    child: MaterialApp(
      title: 'Chop Chop',
      theme: ThemeData(
        primarySwatch: Colors.blue,
        fontFamily: 'Poppins'
      ),
    home: AuthenticationWrapper(),
    ),
  );
}
```

D.7 Partial Code for user_model.dart

```dart
class UserModel {
  static const NAME = "name";
  static const EMAIL = "email";
  static const UID = "uid";
  static const LOCATION = "location";
  static const CART = "cart";
  static const ORDERS = "orders";

  String _name;
  String _email;
  String _uid;
  List<OrderModel> cart;
  PlaceModel locationDetails;
  List<OrderModel> orders;

  String get name => _name;
  String get email => _email;
  String get uid => _uid;

  UserModel.fromSnapshot(DocumentSnapshot documentSnapshot) {
    _name = documentSnapshot.data()[NAME];
    _email = documentSnapshot.data()[EMAIL];
    _uid = documentSnapshot.data()[UID];
    cart = _convertOrderFromMap(documentSnapshot.data()[CART]);
    orders = _convertOrderFromMap(documentSnapshot.data()[ORDERS]);
    locationDetails = _convertLocationDetails(documentSnapshot.
    data()[LOCATION]);
  }

  UserModel();
```