Developing an app that uses smart reminders to support habit formation

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CM3203 One Semester Individual Project

40 CREDITS

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Abstract

Habits make up around 40 percent of our daily actions [16], therefore making it crucial that people develop and maintain healthy habits. However, there is a lack of societal knowledge surrounding the habit formation process, which has consequently lead to widespread formation of unhealthy habits like smoking. There are numerous apps currently on the market that claim to support habit formation through the use of regimentally timed reminders and self-trackers. Studies have shown that this is an ineffective method of supporting habit formation [7] because a reliance is likely to form on the reminders, resulting in the user not actually forming the habit but instead, only performing the desired behaviour after notification delivery. It is for this reason, that an Android app was developed in this project with the intention to teach users about the theory of habits and encourage the use of event-based cues [6]. These are cues that are dependent on another event that already occurs daily, for example brushing teeth. This contrasts to time-based cues, which occur at a set time every day. Randomly timed notifications were implemented in this app and were delivered after the expected timeframe of behaviour completion. This was in an attempt to prevent a dependency being formed on the reminders, like in current apps. Ten participants completed a five-day study to evaluate the usability and feasibility of the app. The results suggested the app was very user friendly and scored an above average score of 91.75 on the system usability survey [30]. All participants reported that they had gained a greater knowledge of what habits were and how they were formed and expressed an overall satisfaction with the apps functionality. Different versions of Android software lead to some users not receiving notifications but positive feedback was given from those who did. The results from this study suggest that the design and functionality of the high fidelity prototype developed during this project could be an effective alternative of supporting habit formation from the current, flawed habit supporting apps.

Acknowledgements

I would like to thank my supervisor, Dr Katarzyna Stawarz, for her invaluable support and guidance throughout this project.

I would also like to thank my friends and family for their support throughout this project and taking the time to complete my study. Their participation was crucial for the evaluation of this project.

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1. Introduction

The aim of this project is to develop a high fidelity prototype of an Android app that supports habit formation. It will not be focused on time-based reminders, like current habit formation apps [1], but instead will use psychological theories to guide the user through their habit development. It is intended to help people develop healthy habits by learning about how habits work and the process of building new ones effectively. No prior knowledge about habits will be needed by the target audience to use the app and its purpose is to deliver the relevant information to the user in order to make habit formation easier.

The main objectives of the project:

- Use psychological theories to find an alternative to time-based reminders
- Develop a high fidelity prototype of an Android app to support habit formation
- Provide users with the resources to learn about the process of habit formation
- Allow users to tailor the app to suit their personal needs and fit into their daily routine
- Make the app user-friendly and easy to use
- Create an interactive app that presents the information in a way that is aesthetically pleasing to the user

To complete this, detailed research into psychological theories will be carried out to find an alternative method of supporting habit formation that can be implemented in mobile apps. An app will then be created that facilitates the research conducted. Android Studio, an app building software compatible with Android devices exclusively, will be used to develop the app. The design creation and basic functionality of the prototype will be produced using Android Studio guides and user design principles.

Once the app is complete, a short, five-day study will be conducted. The 12-week timeframe assigned for this project means it will not be possible to test the efficiency of supporting habit formation. This is due to the fact it takes an average of 66 days to build a new habit behaviour [2]. Therefore, the study will be used to analyse the usability and feasibility of the app. These findings will be compared with the research to evaluate the success of the project.

This report will be my account of the research, design, implementation, study analysis, evaluation and discussion of this habit formation support app.

2. Background

The Background chapter contains all of the relevant research that has allowed me to complete the project and provides additional context.

2.1. Problem

It is believed that without habits, our brains would simply shut down because they would be overwhelmed by the volume of decisions required in daily life [3]. Healthy habits are thought to be a vital part of creating a healthy lifestyle along with the ability to break bad habits [4]. Examples of habits generally categorised as good are exercising regularly, meditation and make the bed in the morning whereas behaviours such as the consumption of drugs and alcohol are considered bad habits. Therefore, there is a fundamental need for humans to

possess the ability to form and maintain healthy habits but the general population do not retain the specialised knowledge or resources to do so.

With the increased use of mobile technology in modern day life, an app is an easy and convenient method of providing individuals with resources on a large scale. It has been shown that the use of educational apps is increasing and that they can be useful learning tools [5]. However, current habit formation apps on the market attempt to support users using methods that have been shown to be ineffective and present a gap between the theory of habit formation and the practices they demonstrate [6].

Furthermore, people actually do not understand how habits form and while there are a many learning apps, there does not seem to be one that explain how habits form. Therefore, an app that encompasses psychological theories of successful habit formation and presents these practices on an easy, usable interface is required.

2.2. Existing solutions and their limitations

The apps that are currently on the market are based on time based reminders and self-tracking. Such features are not seen to be effective despite user popularity and satisfaction [1]. Reminders are used with the intention of using repetition of the behaviour to form the habit. Yet, a study showed that relying on consistently timed, daily reminders in the attempt to support repetition of the habit can hinder the development of said habit [7]. Time-based reminders create long term reliance therefore requiring long term use of the app in order to have a chance of performing the behaviour automatically [1]. Long term use could be required to ensure the routine is performed as a reaction to a cue that is not the app reminders. If the app reminder becomes the cue to the habit, the behaviour will be extinguished when the use of the app is stopped. The need for long term use often leads to phased out usage of the app, resulting in the behaviour frequently being abandoned as well [1]. Popularity of the apps could be due to the user mistaking the reliance on the app as formation of the habit.

Time-based cues are identified at a specific time of the day and event-based cues are instigated when a certain action is performed, for example when you pick up your toothbrush it cues the routine of also picking up the toothpaste. Evidence suggests that event-based cues led to increased automaticity when compared to time-based cues and that current apps are unable to facilitate event-based cues [1]. Most apps currently on the market use positive reinforcement to aid habit formation, through the use of streaks and reward points when the habit has been carried out. However, evidence suggests that positive reinforcement was an ineffective method of aiding habit formation as it does not affect an individual's ability to form a habit [7].

2.3. Research into habit formation

There are three key stages to a habit; cue, routine, reward [8]. A cue is personal to an individual and triggers the brain to automatically perform the routine connected with that specific cue. A routine can be physical, mental or emotional and leads to a reward which can be intrinsic or extrinsic. The reward helps the brain to decide whether this particular cue and routine is worth remembering for future use. If remembered, a craving for the reward is developed when the cue is presented, driving the brain to perform routine [3], thus creating a loop. As this loop is repeated, it becomes more and more automatic [8]. By simply understanding how this habit loops works, it makes habits easier to control as it allows them to be broken down into its components and manipulated [3]. This knowledge also makes overpowering negative habits easier because new neurological routines can be created to

force bad habits into the background but unfortunately cannot extinguish them completely [3].

Creating new habits can benefit from the awareness of daily routines and cues. Contextual cues have been shown to be more effective than single, vague cues [9], suggesting that new habit development is more effective when incorporated into pre-existing routines [6]. However, study findings show that trial and error is often required to find a cue that works for that specific habit [10]. For example, the new behaviour could fit in better after an individual's breakfast routine as oppose to their showering routine in the morning. A study showed that early failures in remembering played a part in developing a reliable remembering strategy [10].

Willpower is thought to have a great impact on habit formation [11] and can be learnt [3]. Findings from multiple studies suggested that the strengthening of an individual's willpower can support positive habit formation which can transfer into other aspects of life [12] [13]. The same concept is apparent within keystone habits. Keystone habits promote the formation of other good habits [3]. For example, making your bed every morning is correlated with many other healthy habits including regular exercise, greater levels of productivity and better budgeting skills [3].

Having a sense of belief or motivation is thought to be a big part of sustainable habit formation [3]. A study presented that a habit is the repetition of a behaviour that successfully met a motivational need [14]. For example, if the desired habit is stretching after a workout, a motivation for this would be to reduce muscle ache and soreness in the following days. By stretching afterwards, this motivation is fulfilled and therefore more likely to be repeated after the next workout. Motivation can be categorised as intrinsic or extrinsic. Intrinsic motivation is described as doing the action for your personal benefit whereas extrinsic motivation is the pursuit of an external reward or goal [15]. This shows the broad scope of where people get their motives from and the knowledge of this could help manipulate them to aid habit formation.

A paper evaluating the effectiveness of reminders in current apps produced a set of design requirements that provided improved solutions to supporting habit formation in apps based on research [6]. The first requirement of routine creation suggested the new behaviour should be paired with an existing routine. Back-up notifications which were indirect and allowed the user to control when and how they are notified were proposed as an alternative to the time based reminders used in current apps. Finally, post completion checks were suggested which would allow the user to check whether the behaviour has been done after the behaviour has been completed. Therefore, reminders could play a role in habit formation but measures would need to be implemented to prevent users forming a dependency on them.

2.4. Proposed solution

Based on the research summarised above and the limitations of existing technologies, an app will be designed that uses event-based cues to aid the user to insert the habit into their daily routine rather than relying on their daily timings. The app will be based around the three stage habit loop theory [8] and will explain the basic principle of this process. The design requirements found in a research paper [6] will act as the foundation of the solution. These requirements are based on health psychology research and will subsequently bridge the gap between the psychological theories surrounding habit formation and the practices of current apps.

The user will first be asked to think of the habit they wish to develop, examples will be provided to aid the user. The user will be encouraged to pick a keystone habit, such as meditation, making their bed or exercising daily. The basic concept of a keystone habit will

be explained to the user with the intention of the development of such a habit being transferred into other areas of their life. The app will then consist of three core features that aim to guide the development of the user's chosen habit; A, B and C.

Feature A: User's will need to identify pre-existing routines in their daily life, such as brushing their teeth, and specify its general timing (morning, afternoon, evening). Examples of common routines will be provided to help the user reflect on the daily routines in their own life. The user will then be asked to pick one of these routines to associate their desired habit with. The detailed literature showed that habit formation was more successful when contextual cues were embedded in existing routines [9]. As a result, the chosen routine will act as the cue for the new habit. The user will be able to change their cue at any point and will be encouraged to review their progress because research suggested that successful cue selection is likely to require some trial and error [10].

Feature B: Subtle reminders that are flexibly-timed will be used. The app prototype will use reminders unlike current apps do; they will not be regimentally timed. The reminders will be indirect notification to the user's mobile device which is subtly linked to the routine the user has chosen to embed the habit in. An example of such reminder could be "Did you take your pill after you brushed your teeth?". This reminds the user to associate the new behaviour with the existing routine. There will not be a set time for the reminders and will be roughly based around the timeframe of the existing routine. For example, if the routine has been specified to normally take place in the morning, the user could receive a reminder at any point in the day but if the routine is usually in the afternoon, a reminder could be sent any time after midday. The uncertainty of the reminder's timing is to ensure the user does not become reliant on them because they are unpredictable.

Feature C: The final implementation is a tracking system that is to be used once the behaviour has been completed. The tracking system is for the user's own reflection on how successful they have been day to day at performing the habit.

The proposed app will include optional functionality that will aid the user's habit formation process if they choose to use it. The user will be asked to construct a list of reasons why they want to develop this habit. This aims to give the user a sense of belief and help to fuel the strengthening of their willpower when they experience failure or lack of motivation. The users will also be advised to make a list of any potential factors preventing them from performing the behaviour along with possible solutions to tactical these problems. For example, a user might identify time potentially affecting them developing the habit of meditating every morning and the proposed solution could be to set their alarm ten minutes earlier. By identifying any potential obstacles and possible solutions beforehand, the user is better equipped to deal with said problem if it arises. This also highlights why trial and error is useful because it will allow the user to experiment with the methods of mitigation for different limitations they have identified and find out what works from them. The app will promote the use of trial and error by encouraging the user to revaluate factors on a regular basis, like the routine they have established as their cue.

Additional information in a question and answer format will be provided. The answers will be short and concise but contain enough information for the user to gain extra knowledge. This motivates the user to do further research without overwhelming them with information. For users that want even more information, a short list of resources will be provided such as helpful websites, books and research papers. This will be less time consuming as the users are given easy access to useful resources, providing a greater incentive to do it because it is convenient. If these tools are utilised, this should further aid habit formation because the user will gain a greater a knowledge about habits [3].

Conclusions

Habits make up a large proportion of daily life [16], but most individuals lack the knowledge and do not have the time or desire to research the topic of habit formation. Therefore, a mobile app that uses research and presents it in an easy, convenient format would encourage more individuals to learn about and develop healthy habits. The app is only intended for short term use until the user has successfully developed their desired behaviour or has gained the knowledge of how habits are formed successfully. Short term, inconsistently timed reminders will ensure that the user does not become reliant on the app in the long term like with current apps. Instead it will encourage the development of the required skills to form and maintain a habit of their choosing. In the next chapter, the strategy used to implement these findings into the app will be explained along with the justification for this.

3. Approach

During this chapter I will explain my approach to complete this project. It will include a detailed justification of the methodology and software I have chosen to use as well as a plan of the timings of the project.

3.1. Agile Development Methodology

This project will follow an Agile development methodology [17] because of its iterative approach will allow app requirements and solutions to evolve throughout the project. This is beneficial for this project due to my limited of experience creating Android apps. It will grant sufficient time to carry out research in order to learn and develop the necessary skills to complete the app to a high standard as well as a flexible timeframe to investigate any problems that arise. An agile approach allows work on the documentation and app development simultaneously, allowing milestones and events to be documented when they occur to avoid details or processes being forgotten.

The project will be partitioned into sections of work, making it less overwhelming and more manageable. These sections will contain milestones linked with an estimated completion date which will ensure work is completed promptly in order to remain on track. The breakdown of these sections, their milestones and completion dates can be seen in the Gantt chart shown in figure 3.1. This work plan has been shared and discussed with the project supervisor and will be reviewed regularly to ensure any issues are resolved, allowing the project to be completed on time with all of the sections completed.

Figure 3.1: Gantt chart
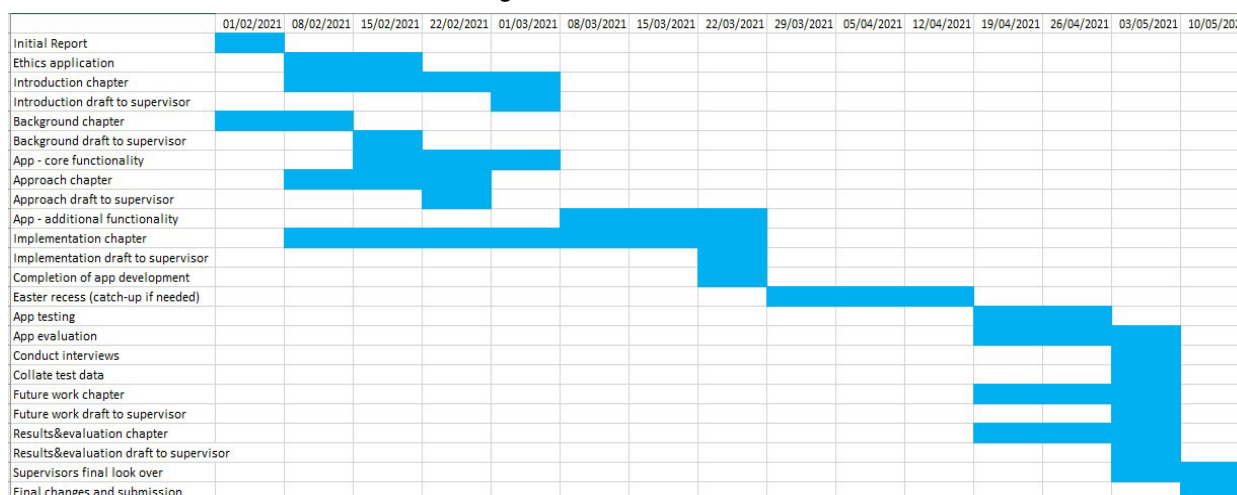
3.2. Development Solution

The decision to develop a mobile app for this project was based on my own personal interest and willingness for a challenge as it seemed like an invaluable learning opportunity given the course had not covered app development. The only constraint of app development that arose was the compatible of the software with different operating systems. Software's varied in their compatibility with Android and iOS, some facilitated both. To justify this decision, I conducted research to explore which software was most fitting for me personally and the project itself.

I chose to develop the app exclusively on Android because it provides all of the functionality needed for the project. Its software, Android Studio, uses Java which I have experience using as oppose to iOS development software that uses Swift. Using a language I am sufficient in allowed more time to focus on the implementation of design rather than learning an entirely new language, thus allowing me to produce a more refined solution at the expense of it not being accessible on iOS devices. I thought the sacrifice of iOS compatibility was justified on this basis and also made the challenge of developing an app more attainable due to the familiarity of the syntax. Android development also does not have the licensing limitations that iOS poses and therefore seemed like the more convenient option given the timescale of the project. Developing the app on Android made recruiting participants for testing of the app at the end of development more accessible as numerous family members and friends own Android devices and Android allows for easy, straightforward distribution of the app.

3.3. Android Guides and Resources

Android Studio has numerous tutorials and guides for basic and advanced apps which would be vital for development. Android have published official documentation called Android Development Documentation [18] which goes step by step through the key features of development; this includes insightful examples and detailed descriptions. Android also provide free courses that teach the skills needed to develop apps of various complexities [19] [20]. This alongside YouTube videos and websites such as Stack Overflow [21] have given me the resources to develop my app.

3.4. Data Storage

All of the data inputted by the user needs to be stored in a database so it can be viewed and modified throughout their use of the app. Therefore, I researched different methods of storing data that were compatible with Android Studio. I decided that a NoSQL database was the most appropriate because it has quick retrieval times that are required for a real time application. My third year module, Large Scale Databases (CM3104), has given me prior experience of working with NoSQL databases. I made the decision to use Firebase's cloud hosted, NoSQL database called Cloud Firestore [22]. Firebase is a mobile platform, made by Goggle, that aids the development of mobile apps. It has a variety of tools and services as well as detailed documentation to aid set up. This will allow me to set up the database, store and manipulate data with relative ease because it is an add-on to Android Studio.

Conclusions

During this chapter, I have detailed my approach to fulfil the project aim, as well as the methodology and software I will be using. Next, I will identify the user requirements that are needed for this project based on the research carried out in the Background chapter.

4. Specification

This chapter presents the user requirements that are based on the research conducted in the Background chapter. The purpose of this is to get a clear idea of what the app must contain in order to be achieve the aim of the project.

4.1. User Requirements

During the Developing Quality Software (CM2102) module in my first year, I gained the knowledge of how to compose detailed lists of functional and non-functional requirements needed to build a given piece of software. I have been able to utilise this skill and use it in the design of this project, allowing me to get a clearer idea of the essential features and requirements needed to build a user-friendly and practical app. The following requirements have been derived from the research conducted in the Background chapter.

The must have functional requirements are listed below; their acceptance criteria can be found in the Appendix A (see section 10.1.) along with could have and should have functional requirements and their respective acceptance criteria. The non-functional requirements can also be found in the Appendix A (see section 10.1).

MUST HAVE Functional Requirements:

- FR1: The user must be able to enter their habit of choice with examples provided for guidance

- FR2: The user must be able to enter their pre-existing routine, prompted by examples
- FR3: The user must be able to view their chosen habit, the pre-existing routine they have affiliated it with and the timeframe of that routine on one page.
- FR4: The user must be able to view all of the routines they have identified on one page.
- FR5: The user must be able to enter motivations for developing their habit of choice
- FR6: The user must be able to view all identified motivations for forming the habit on one page.
- FR7: The user must be able to enter potential limitations in their development of the habit and their possible solutions.
- FR8: The user must be able to view all of the potential limitations they identified along with the possible solutions they presented on one page.
- FR9: The user must have access to a page of resources, a combination of tips directly on the page and directions to specific external resources

4.2. Use Cases

All use cases are under the assumption that the user has already been provided with basic information about the process of habit formation. See Appendix B (section 10.2) for the individual use cases.

The use case diagram shown in figure 4.1 presents the use cases for the app which are based on the must have section of the user requirements.

Figure 4.1: Use Case Diagram
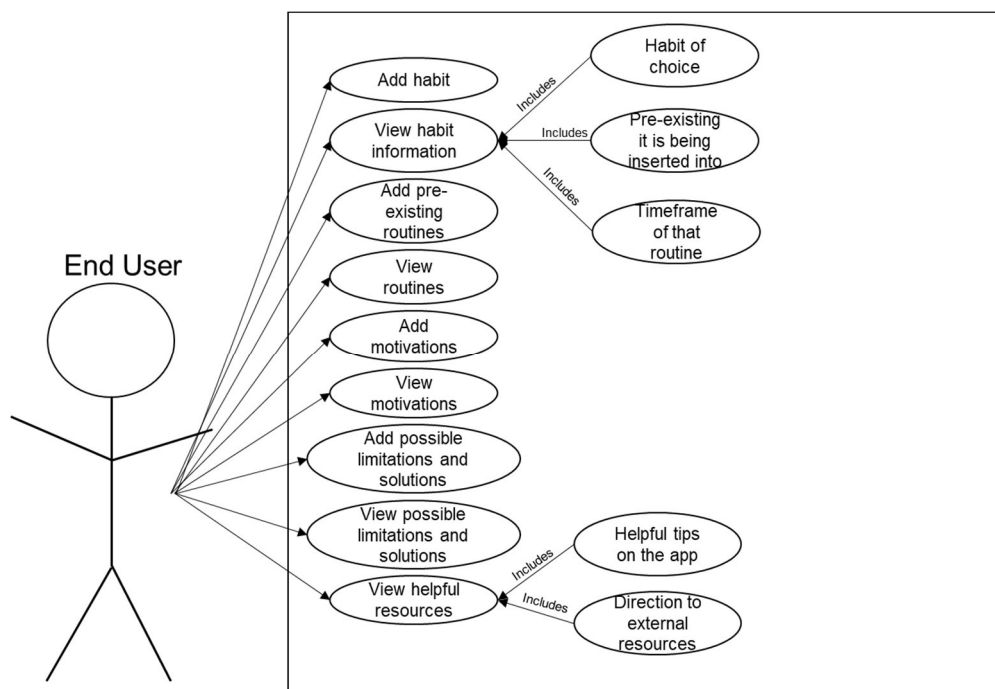
Conclusions

This chapter has allowed me to generate a comprehensive set of user requirements and use cases. The next chapter will detail how these specifications have been utilised in the design of the app.

5. Design and Implementation

In this chapter, I present a record of the design process that was undertaken to achieve the final design of the app prototype, followed by an account of the implementation process. This was done using the functional requirements and use cases that were derived in the previous chapter (Approach). Alongside this, multiple usability principles were applied to ensure that users could easily navigate around the app.

5.1. Design

5.1.1. User Interface Prototypes

Usability for this app was a priority because users are more likely to use the app if they can navigate their way around it with ease [27]. Therefore, it was imperative that prototypes of the app were made to ensure that the design of each feature was thought about at length before implemented. This allowed the app to be visualised to determine what it would look like and how users would interact with it before the app was developed, allowing flexibility to adapt layouts and features without the strain of changing any code. During the design of the prototypes, the identified functional requirements and the use cases (see Specification chapter) were thought of mindfully to ensure core functionality was designed to a high standard.

During this design process, I aimed to apply Nielson's heuristic principles [28] and C.R.A.P principles [25]. Nielson's heuristics are 10 general principles to evaluate the usability of interactive designs such as apps and websites. Visibility of system status, consistency and standards and recognition rather than recall are some of the principles. These are measured using Nielson's 0-4 rating scale, zero meaning "I don't agree that this is a usability problem at all" and four defined as "usability catastrophe: imperative to fix this before product can be released" [28]. The purpose of the rating scale is to produce a quantitative assessment of the impact of any usability problems. C.R.A.P principles assess the design of the interface using four principles: contrast, repetition, alignment and proximity. The evaluation of the C.R.A.P principles was also measured using Nielson's 0-4 rating scale. I focused on applying these principles in my final prototype to ensure users would be able to use the app with ease.

The prototypes were designed using a software called Balsamiq Cloud [23], a web-based interface that can be used to create mock-ups for design purposes. However, Balsamiq Cloud is a basic interface and therefore comes with its limitations, such as its limited variety of Android based tools and icons. Consequently, the prototypes produced will not be completely accurate and the design will differ slightly when implemented.
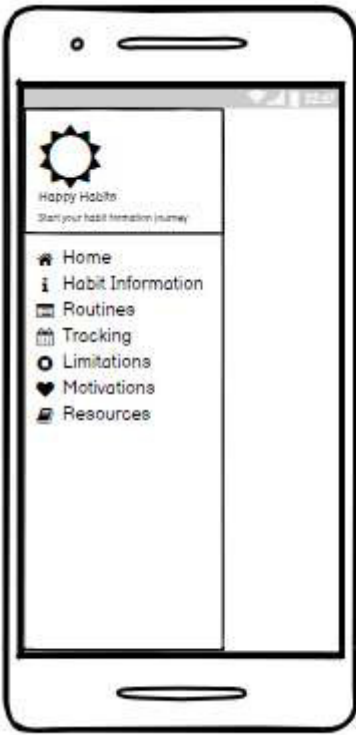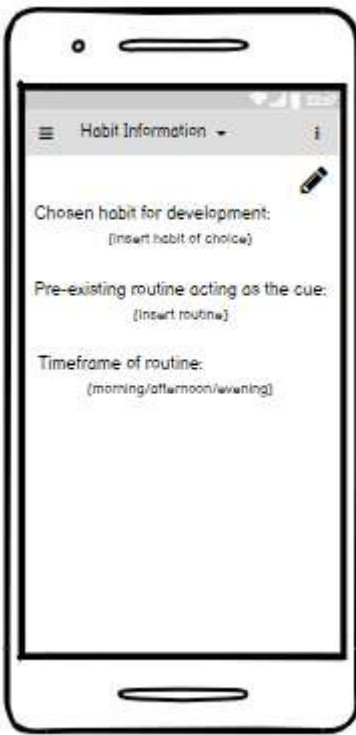
5.1.2. Initial Prototype:

The initial prototype was created at the start of the project to form a basic idea of the type of app needed and proved extremely helpful at the start of development. It was informed by the use cases and functional requirements (see Specification chapter) to ensure that all of the essential functionality was covered.

A side bar navigation system was designed to direct the user to different screens. This would allow the user to access the following screens: habit information, routines, motivations and limitations. Each of these screens displayed the relevant information and had an edit button directing the user to the edit screen allowing the amendment and addition of information. The side bar navigation also included a link to the resources page which provided the user with additional information about habit formation.

Figure 5.1 shows three designs from the initial prototype. The full initial prototype design with descriptions and connecting use cases can be found in Appendix 3 (see section 10.3).

Figure 5.1: Initial Prototype Screens

Side Bar Navigation	Habit Information Screen	Routines Edit Screen
This can be accessed by pressing the three lines in the top left corner of any page, a generic format for apps. It will allow the user to access all of	This page will display all of the core information about the user's habit of choice. The Android icon for edit in the top right above the text. Pressing the edit icon allows the user to	This page allows the user to add routines they already perform daily. The back button is placed in the top left corner and the submit button is located under the editing

the pages shown by clicking on the one they wish to go to. Relevant use case(s): UC2, UC4, UC6, UC8, UC9 - The side bar is needed to be able to access the pages to view the information.	edit the habit information they have inputted. Relevant use case(s): UC1, UC2	options. A drop down menu is provided for the timeframe for the timeframe input for ease for the user and consistency of answers. Relevant use case(s): UC3

5.1.3. Usability Evaluation of the Initial Prototype

I evaluated this prototype using Nielson's heuristic principles and C.R.A.P principles (see section 5.1.1.). To do this, each screen design was assessed to see how it related to each principle. Overall, I concluded the main weaknesses of the initial prototype was the lack of context and the aesthetic. The design required more descriptions about each screen's purpose and repetition of information to help the user understand the habit development process. The solution I identified was to include short, insightful explanations on each screen to provide guidance and context. The initial prototype design was not eye-catching and would not appeal to users. To overcome this, I planned to implement a colour scheme and apply a consistent design throughout. Detailed documentation about the usability evaluations of the initial prototype can be found in Appendix D (see section 10.4).
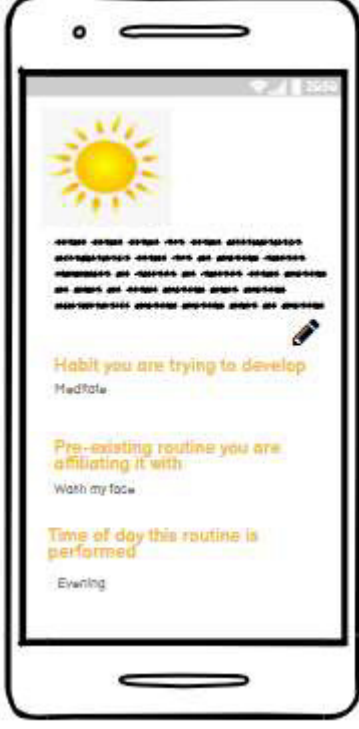
5.1.4. Final Prototype

After reviewing the usability evaluations, I modified most of the screens whilst keeping the side bar navigation the same. The main modification of the prototype was the implementation of a colour scheme and a consistent layout throughout which provided a good level of contrast. A yellow and dark grey colour scheme was decided because yellow is seen as a happy, inspirational and creative colour [24], which I considered to be an appropriate theme for the app. Along with this theme, a sunshine was defined as the logo because it is basic and can be easily implemented across the app for consistency purposes. The colour scheme was made sure to be colour blind inclusive [26].

Since the creation of the initial prototype, a login system was added onto the apps functionality as well as onboarding screens within the app that could be accessed even after first use. This was done after considering the heuristic principle of recognition rather than recall.

Figure 5.2 shows three designs from the final prototype. The whole final prototype design can be found in Appendix E (see section 10.5).

Figure 5.2: Final Prototype Screens

Login Screen	Home Screen	Habit Information Screen

A login system has been implemented. An enlarged logo is displayed and the user is able to enter their email and password or go to the create account if they do not have one.	The home screen in the initial prototype did not have much use so I changed its function to inform the user of key information about habits and links them to the resources page if they want more information. The icon used in the side bar navigation is also shown next to this for consistency purposes.

There is also a large banner button that takes them to a series of onboarding screens containing information about getting started and the recommended flow to set up. | The logo is shown in the top right hand corner and there is a block of text underneath giving information about habits. This applies the help and documentation C.R.A.P principle and the recognition rather than recall heuristic principle. The block text is in bold because it is important for the user to read and is provides contrast to the layout. This is followed by an edit button on and the habit information the user has inputted. This layout is consistent with all of the pages that display user input. |

The final prototype provides further information into the habit formation process and provides more aids to guide the user during their development. This design was implemented and used in the study with only minor alterations made due to the limitations of design in Balsamiq Cloud.
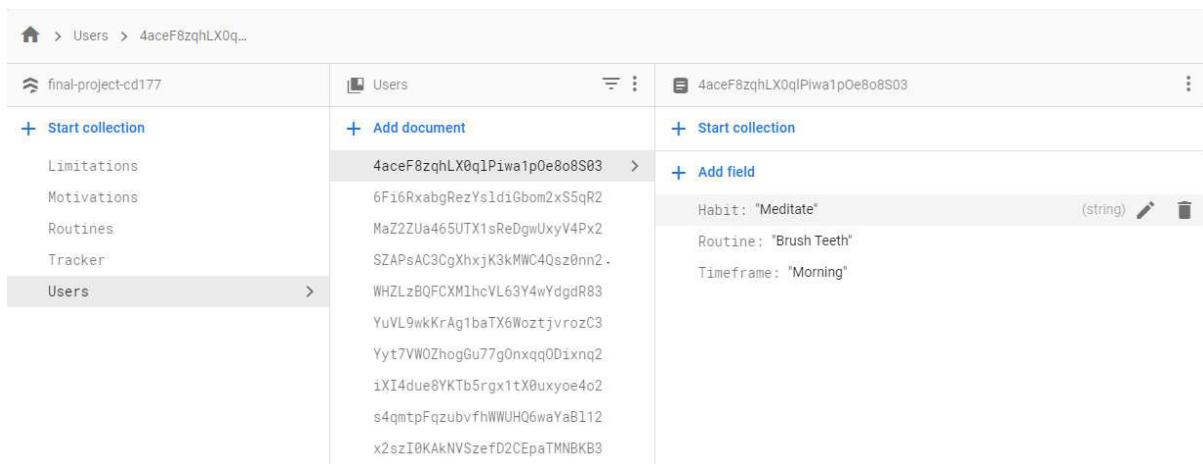
5.2. Implementation

The app was created in Android Studio using Java and made use of Firebase Firestore to store data. Implementation was based on the final prototype design (see section 5.1.4).

5.2.1. Database Design

To store all of the user's data, Firestore NoSQL database was used. The database consists of five collections: users, routines, motivations, limitations and tracker. The user collection contains documents, all named after the user's ID and contain the user's habit, the routine they have chosen to affiliate it with and its timeframe. The routines document contains the user's ID, their routine and its timeframe. The name of the document is auto-generated and each document only holds one of the user's routines. The motivations and limitations collections have the same format as the routine collection. The tracker collection contains documents named after the user's ID and records the date every time the user says they have completed the habit behaviour. The structure of the database is shown in figure 5.3 below.

Figure 5.3: Database structure

5.2.2. Overview of implementation

Figure 5.4 shows the basic structure of the app.

The *AndroidManifest.xml* contains important information about the app, such as permissions, information about the activities and defines the launcher activity. This information is used by the Android operating system when it is running.

Figure 5.4 shows all of the classes that were used in the development of the app. The design of the app was based on the implementation of a side bar navigation system. This meant anything relating to the side bar was classed as a fragment rather than an activity. In order to interact with each fragment, they required their own package that consisted of the fragment and a view model. The view model code was generic throughout but the fragment was linked to the relevant layout and performed any interaction required such as retrieving or inputting data to the database.

There are four activities: *login, create account, alarm receiver* and *main*. The *login* and *create account* activities allowed the user to interact the login system. The *main* activity was the core class used once the user had logged in, mapping the foundations of the app and its navigation system. Notifications were also produced using the *main* activity but referred to code in the *alarm receiver* activity.

The *res* folder contains all of the information needed for the interface design, including all of the layouts, colour schemes and images.

Figure 5.4: App structure
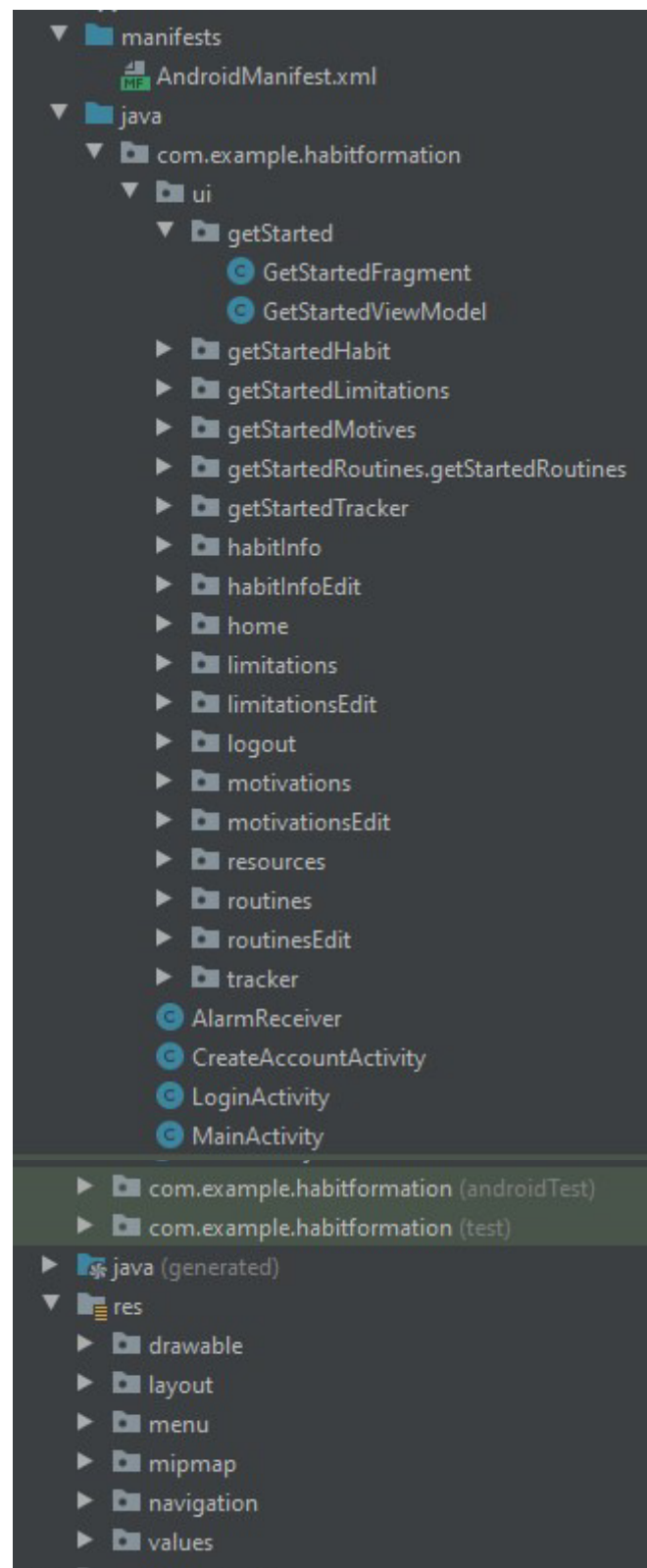
5.2.3. Key Features

Login system

The login system allowed users to have their own secure account that retained all of their habit information and progress. It connected with the database using `firebaseAuth` to ensure that the details provided were correct. If the user did not fill in all of the fields, the app would produce prompts to help the user and would also show a popup message telling them if logging in was successful or not. See figure 5.5 for code implementation.

Figure 5.5: Login system code

```java
private void Login(){
    String email = emailText.getText().toString();
    String password = passwordText.getText().toString();
    if (TextUtils.isEmpty(email)){
        emailText.setError("Please enter your email");
        return;
    }
    else if (TextUtils.isEmpty(password)){
        passwordText.setError("Please enter your password");
        return;
    }
    progressDialog.setMessage("Please wait...");
    progressDialog.show();
    progressDialog.setCanceledOnTouchOutside(false);
    firebaseAuth.signInWithEmailAndPassword(email, password).addOnCompleteListener( activity: this, new OnCompleteListener<AuthResult>() {
        @Override
        public void onComplete(@NonNull Task<AuthResult> task) {
            if (task.isSuccessful()){
                Toast.makeText( context: LoginActivity.this, text: "Login Successful", Toast.LENGTH_LONG).show();
                startActivity(new Intent( packageContext: LoginActivity.this, MainActivity.class));
                finish();
            }
            else{
                Toast.makeText( context: LoginActivity.this, text: "Login Unsuccessful", Toast.LENGTH_LONG).show();
            }
            progressDialog.dismiss();
        }
    });
}
```

If the user does not have an account, they are able to make one. This is also done using `firebaseAuth` which authenticates the email and ensures the password is six characters long for security purposes. The user also has to input the password twice to ensure they have not made my typing errors. See figure 5.6.

Figure 5.6: Login system validation code

```java
    firebaseAuth.createUserWithEmailAndPassword(email, password).addOnCompleteListener( activity: this, new OnCompleteListener<AuthResult>() {
        @Override
        public void onComplete(@NonNull Task<AuthResult> task) {
            if (task.isSuccessful()){
                Toast.makeText( context: CreateAccountActivity.this, text: "Account has been created", Toast.LENGTH_LONG).show();
                startActivity(new Intent( packageContext: CreateAccountActivity.this, LoginActivity.class));
                finish();
            }
            else{
                Toast.makeText( context: CreateAccountActivity.this, text: "Account has NOT been created", Toast.LENGTH_LONG).show();
            }
            progressDialog.dismiss();
        }
    });
}

private Boolean isValidEmail(CharSequence goal){
    return (!TextUtils.isEmpty(goal) && Patterns.EMAIL_ADDRESS.matcher(goal).matches());
}
```

Figure 5.7 shows the storage of user accounts. The password is not visible to the database administrator for security purposes and the User UID provides anonymity. The identifier has been redacted in this figure to hide the user's identity.

Figure 5.7: Storage of users accounts

Identifier	Providers	Created	Signed In ↓	User UID
████████████	✉	Apr 19, 2021	Apr 26, 2021	vWghKCmNB8PWQRppHppV4N1...
████████████	✉	Apr 19, 2021	Apr 26, 2021	jHSDHpc7NuMOPq4LKTlKQuochG...

Drop down menu on habit information edit screen

When inputting a habit to develop on the Habit Information edit screen, the input of the affiliated routine is a spinner consisting of all of the routines the user inputted on the Routines screen. This makes the selection of the routine easier for the user and saves the user repeating themselves by re-entering the routine and its timeframe. This was done by extracting all of the routines with the specific user ID from the database and putting it into an array, that can be used to populate the spinner. Once the user has selected a routine, the database searches for that routine with that user ID to find the timeframe relating to it. Figure 5.8 shows the implemented code.

Figure 5.8: Drop down menu on habit information edit screen

```java
CollectionReference refer = db.collection( collectionPath: "Routines");
Query q = refer.whereEqualTo( field: "Username", userUid).limit(8);
sRoutineText = root.findViewById(R.id.spinner);
List<String> routines = new ArrayList<>();
ArrayAdapter<String> adapter = new ArrayAdapter<>(getActivity().getApplicationContext(), android.R.layout.simple_spinner_item, routines);
adapter.setDropDownViewResource(android.R.layout.simple_spinner_dropdown_item);
sRoutineText.setAdapter(adapter);
q.get().addOnCompleteListener(new OnCompleteListener<QuerySnapshot>() {
    @Override
    public void onComplete(@NonNull Task<QuerySnapshot> task) {
        if (task.isSuccessful()) {
            for (QueryDocumentSnapshot document : task.getResult()) {
                String routine = document.getString( field: "Routine");
                routines.add(routine);
                progressDialog.dismiss();
            }
            adapter.notifyDataSetChanged();
        }
        progressDialog.dismiss();
    }
});
```

Inputting data

Inputting data into the database uses `firebaseAuth` and `getUid`. `getUid` is used to identify what user account is using the app and then all of the relevant data is put into a hash map before it is stored into the specified document. See figures 5.9 and 5.10.

Figure 5.9: Preliminary code for inputting data.

```
FirebaseUser user = FirebaseAuth.getInstance().getCurrentUser();
String userUid = user.getUid();
```

Figure 5.10: Inputting data code

```
routine = routineText.getText().toString();
timeframe = timeframeText.getSelectedItem().toString();
if (routine.isEmpty() || timeframe.isEmpty()){
    return;
}

Map<String, Object> routineAdd = new HashMap<>();
routineAdd.put("Username", userUid);
routineAdd.put("Routine", routine);
routineAdd.put("Timeframe", timeframe);
db.collection( collectionPath: "Routines").document().set(routineAdd);
```

Retrieving and displaying data

Presenting the data stored in the database requires the use of `firebaseAuth` and `getUid` to find out the user using the app, which allows a query to be formulated that finds the required document. Once the data has been retrieved, it is made into a string and each field is set to a specified text view. See figures 5.11 and 5.12.

Figure 5.11: Query to retrieve data from a document

```
FirebaseUser user = FirebaseAuth.getInstance().getCurrentUser();
String userUid = user.getUid();

private DocumentReference ref = FirebaseFirestore.getInstance().collection( collectionPath: "Users").document(userUid);
```

Figure 5.12: Retrieving and displaying data code

```java
ref.get().addOnSuccessListener(new OnSuccessListener<DocumentSnapshot>() {
    @Override
    public void onSuccess(DocumentSnapshot documentSnapshot) {
        if (documentSnapshot.exists()) {
            String habitText = documentSnapshot.getString( field: "Habit");
            String routineText = documentSnapshot.getString( field: "Routine");
            String timeframeText = documentSnapshot.getString( field: "Timeframe");
            habit.setText(habitText);
            routine.setText(routineText);
            timeframe.setText(timeframeText);
            progressDialog.dismiss();
        }
        if (!documentSnapshot.exists()) {
            progressDialog.dismiss();
        }
    }
});
```

Notifications

Notification timings are set using the timeframe of the routine the user is affiliating their habit to. A random time is generated in a specific range depending on the timeframe. Figure 5.13 shows the flow of the notification system.

Figure 5.13: Notifications flowchart
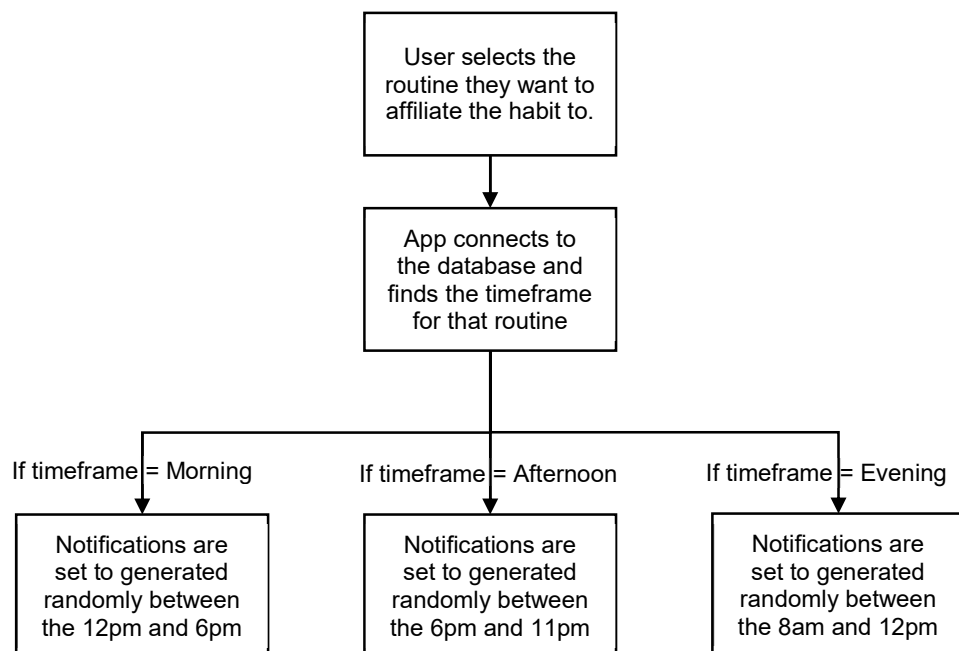
The *Main* activity is responsible for sending the notifications at the generated time, using `NotificationManager,` `AlarmManager` and `PendingIntents.` The *Alarm Receiver*

activity details the display of the notification such as its text and positioning. This is done using `NotificationCompat, Intents` and `PendingIntents`. See figures 5.14 and 5.15.

In *Main* activity:

Figure 5.14: Notification implementation in *Main* activity

```java
notifyManager = (NotificationManager)getSystemService(NOTIFICATION_SERVICE);
Intent notifyIntent = new Intent ( packageContext: this, AlarmReceiver.class);
PendingIntent notifyPendingIntent = PendingIntent.getBroadcast( context: this, NOTIFICATION_ID,
        notifyIntent, PendingIntent.FLAG_UPDATE_CURRENT);
AlarmManager alarmManager = (AlarmManager)getSystemService(ALARM_SERVICE);
ref.get().addOnSuccessListener(new OnSuccessListener<DocumentSnapshot>() {
    @Override
    public void onSuccess(DocumentSnapshot documentSnapshot) {
        if (documentSnapshot.exists()) {
            timeframe = documentSnapshot.getString( field: "Timeframe");
            Calendar calendar = Calendar.getInstance();

            if (timeframe.equals("Morning")){
                Random rand = new Random();
                Integer min = 12;
                Integer max = 19;
                Integer hour = rand.nextInt( bound: max-min)+min;
                Integer minute = rand.nextInt( bound: 60);
                calendar.set(Calendar.HOUR_OF_DAY, hour);
                calendar.set(Calendar.MINUTE, minute);
                calendar.set(Calendar.SECOND, 10);
                alarmManager.setRepeating(AlarmManager.RTC_WAKEUP, calendar.getTimeInMillis(), AlarmManager.INTERVAL_DAY, notifyPendingIntent);

            }
            else if (timeframe.equals("Afternoon")){
                Random rand = new Random();
                Integer min = 18;
                Integer max = 23;
```

In *Alarm Receiver* activity:

Figure 5.15: Notifications code in *Alarm Receiver* activity

```java
    @Override
    public void onReceive(Context context, Intent intent) {
        notifyManager = (NotificationManager)context.getSystemService(Context.NOTIFICATION_SERVICE);
        deliverNotification(context);
    }
    private void deliverNotification(Context context){
        Intent contentIntent = new Intent(context, MainActivity.class);
        contentIntent.setFlags(Intent.FLAG_ACTIVITY_CLEAR_TOP);
        PendingIntent contentPendingIntent = PendingIntent.getActivity(context, NOTIFICATION_ID,
                contentIntent, PendingIntent.FLAG_UPDATE_CURRENT);
        NotificationCompat.Builder builder = new NotificationCompat.Builder(context, PRIMARY_CHANNEL_ID)
                .setContentTitle("Alert")
                .setContentText("Did you work on your habit? Record your progress...")
                .setSmallIcon(R.drawable.ic_android)
                .setContentIntent(contentPendingIntent)
                .setAutoCancel(true)
                .setPriority(NotificationCompat.PRIORITY_HIGH)
                .setDefaults(NotificationCompat.DEFAULT_ALL);
        notifyManager.notify(NOTIFICATION_ID, builder.build());

    }
}
```

Conclusions

To conclude, a variety of features were designed and implemented during the development process, which complied with the functional requirements and the use cases (see Specification chapter). The usability and feasibility of the app was carefully considered and features were designed in mind of this. In the next chapter, a study that was conducted to test the usability and feasibility of the app is described. The effectiveness of the app could not be tested in the timeframe.

6. Results and Evaluation

This chapter gives a detailed report about the study that was conducted to test the usability and feasibility of the prototype app and the findings from the study.

6.1 Method

Participants

Fifteen people were recruited to test the prototype app for five days. Ten people completed the five-day testing and sent back the relevant surveys. When planning the study in the early stages of app development, an assumption was made that not all participants would finish all of the necessary stages and therefore more participants were enlisted to account for this with the hope of having a sample size of at least 10 people.

Procedures

It takes 66 days to form a habit [2] and therefore it was not feasible to test the effectiveness of the app within the time constraints. Consequently, the usability and feasibility was analysed instead. Semi-structured interviews were also conducted on a sample of five participants to gain further insight into their experience with the app. Both surveys and interview guide questions can be found in Appendix F, G and H (see sections 10.6, 10.7 and 10.8).

At the start of the first day, consent forms and installation instructions were sent out to all of the participants and technical assistance for any installation issues was provided. The participants then used the app for five days and at the end of the fifth day, the users were sent two surveys to complete.

The first survey was a standardised survey on the app's usability. This consisted of 10 statements that the participants ranked on a scale from one to five, one being strongly disagree and five being strongly agree.

The second survey was a feasibility survey that was created solely from the purpose of this project. The layout of the survey was similar to the first and consisted of eight questions that the participants also ranked on a scale from one to five, one being strongly disagree and five being strongly agree.

Interviews were carried out within three days of the participants finishing testing. They were asked questions based on the same topics but depending on the answers given, different prompts were used in order to get an informative, descriptive response. After the interviews

were conducted, thematic analysis was performed. I chose to use thematic analysis because it is a widely used method of analysing quantitative data by identifying patterns in data sets.

Analysis

There is a specific method to analysis the System Usability Survey [29] [30]. For odd numbered questions, the score will be subtracted by one and for even numbered questions, the score will be subtracted from five. Once these values have been calculated they are added together and multiplied by 2.5. Finally, an average is taken from each user to generate the final score. This score is out of 100 but is not a percentage [30]. The average System Usability Scale score is 68 meaning that anything above this is deemed to be a good, usable system [29]. In the findings, the calculated values for each question are shown in graphical form to show the general trend.

Analysing the data from the feasibility study consisted of collating all of the answers, presenting a graph showing the distribution of ranking and calculating an average for each individual question.

Thematic analysis is comprised of six phases [31]. Firstly, data was familiarised by listening to all of the interviews again. Secondly, codes were generated for important points and data was collated relating to each code. Then, these codes were used to identify potential themes and any additional data relevant to these themes was gathered. At the fourth phase, the themes were reviewed to ensure the codes produced, linked to the themes. Once the themes were confirmed to be relevant, they were defined and named and the overall story for each theme was created. Finally, quotes relevant to the themes were extracted from the participant's interviews to complete the findings report.

The table in figure 6.1 shows all of the participants in the study, their relevant information and whether they completed the entire study including the surveys and the interview if they were chosen to do so. The participants are referred to by number to comply with the terms of the ethical approval of this study.

Figure 6.1: Information about study participants

Participant Number	Age	Gender	Android Version	Habit of Choice	Completed the entire study	Completed both surveys	Interviewed?
1	54	F	11	Mindfulness for 10 minutes	YES	YES	YES
2	53	M	10	Empty the dishwasher	YES	YES	NO
3	27	M	8	Read before bed	YES	YES	YES
4	28	F	11	Take supplements each morning	YES	YES	NO
5	28	M	11	Stretch for 15 minutes	YES	YES	NO
6	33	F	11	Take make-up off	YES	YES	YES
7	40	M	N/A	N/A	NO	NO	NO
8	27	M	N/A	N/A	NO	NO	NO
9	21	M	11	Meditate	YES	YES	NO

| 10 | 23 | F | 10 | Make my bed | YES | YES | YES |
11	22	F	N/A	Tidy room	NO	NO	NO
12	23	M	11	Gym everyday	YES	YES	NO
13	23	M	N/A	N/A	NO	NO	NO
14	22	F	10	Smoothie	YES	YES	YES
15	22	M	N/A	N/A	NO	NO	NO

6.2 Findings

6.2.1 System Usability Survey
Overall, this survey suggested that participants found the system very usable. The results from the System Usability Survey showed is scored 91.75 overall, meaning the system is considered to have above average usability. In particular, when asked about needing to learn a lot before using the app, all participants strongly disagreed and nine out of 10 participants strongly disagreed to the app containing too much inconsistency.

Figure 6.2 shows the breakdown of this analysis for each question. The maximum score for each question is 4.

Figure 6.2: SUS analysis breakdown for each question
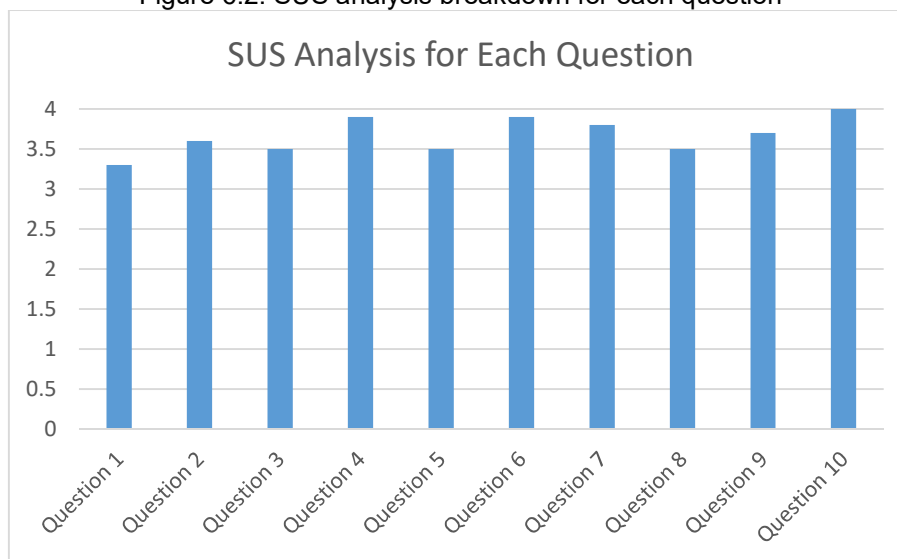
The following graphs show the distribution of answers for each question along with their averages.

1. I think that I would like to use this system frequently.
Figure 6.3 shows the participants response to the statement. The average score for this question was 4.3.
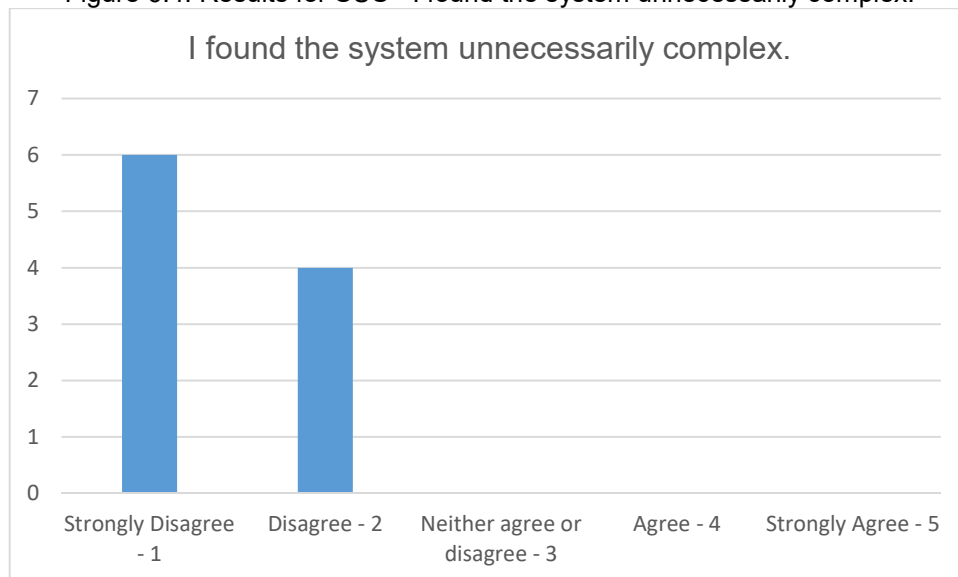
2. I found the system unnecessarily complex.
Figure 6.4 shows the participants response to the statement. The average score for this question was 1.4.

Figure 6.4: Results for SUS - I found the system unnecessarily complex.

3. I thought the system was easy to use.
Figure 6.5 shows that there is an even split between agree and strongly agree, therefore giving it an average score of 4.5.

Figure 6.5: Results for SUS - I thought the system was easy to use.

I thought the system was easy to use.
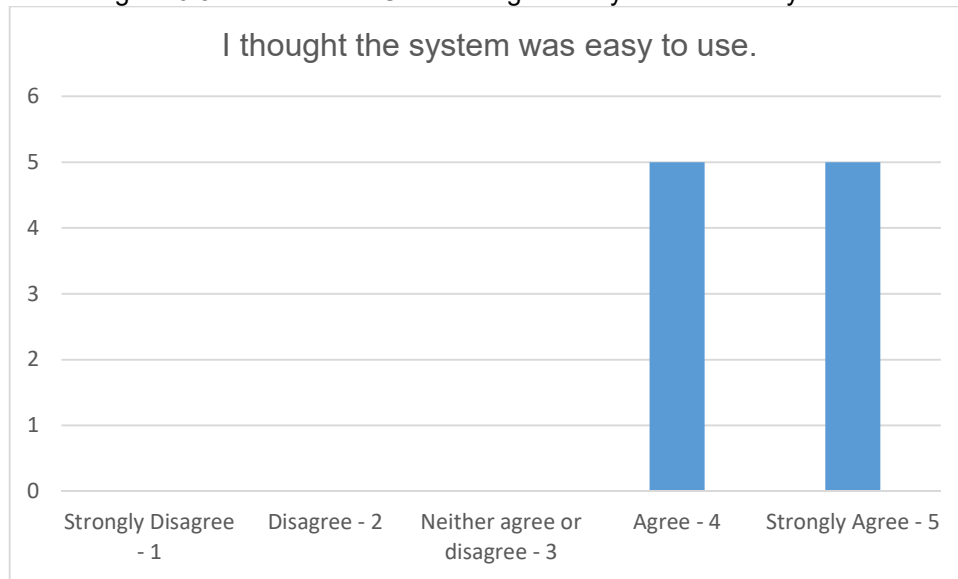
4. I think that I would need the support of a technical person to be able to use this system.

Figure 6.6 shows the majority of participants strongly disagreeing with the statement. The average score for this question was 1.1.

Figure 6.6: Results for SUS - I think that I would need the support of a technical person to be able to use this system.

I think that I would need the support of a technical person to be able to use this system.
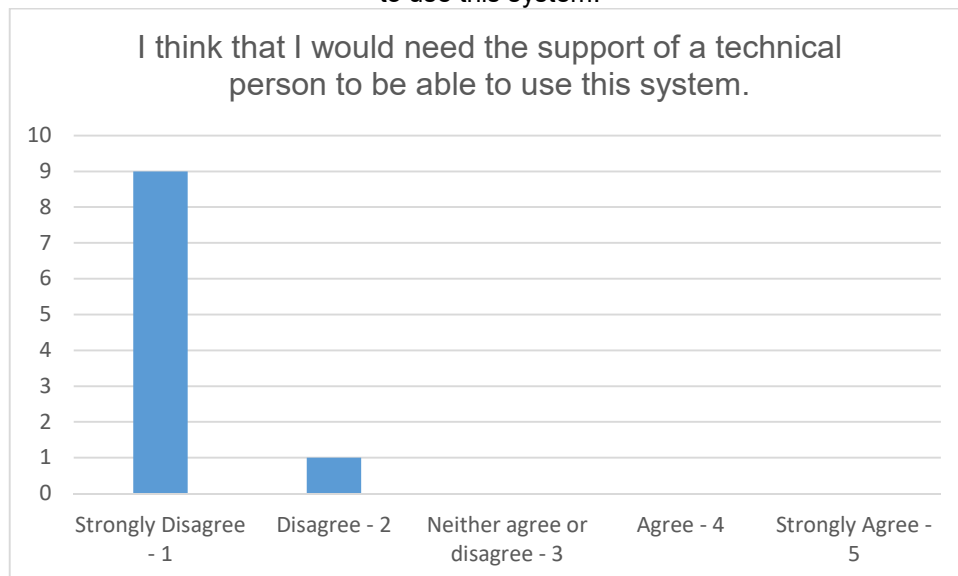
5. I found the various functions in this system were well integrated.

Figure 6.7 shows that there is an even split between agree and strongly agree, therefore giving it an average score of 4.5.

Figure 6.7: Results for SUS - I found the various functions in this system were well integrated.

I found the various functions in this system were well integrated.
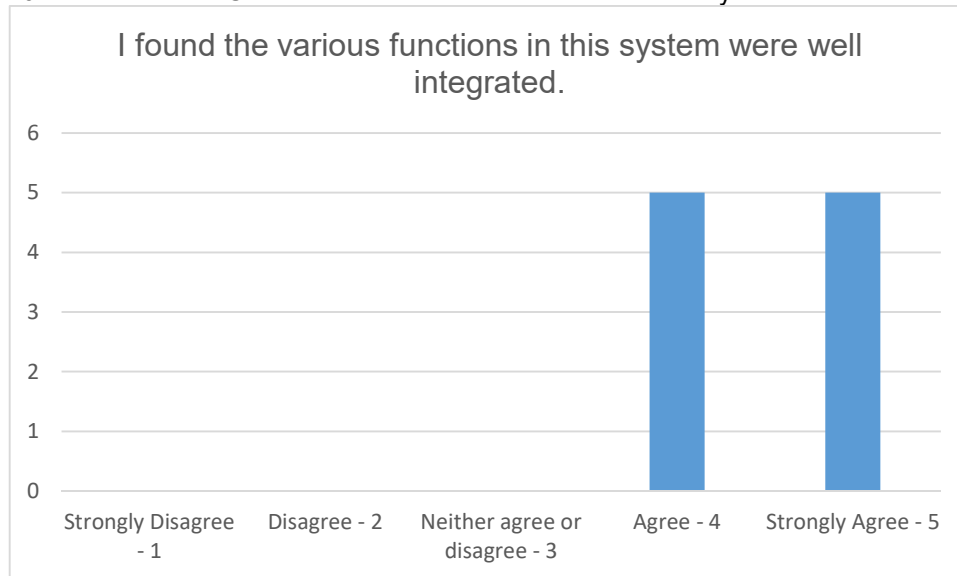
6. **I thought there was too much inconsistency in this system.**
Figure 6.8 shows the majority of participants strongly disagreeing with the statement. The average score for this question was 1.1.

Figure 6.8: Results for SUS - I thought there was too much inconsistency in this system.

I thought there was too much inconsistency in this system.
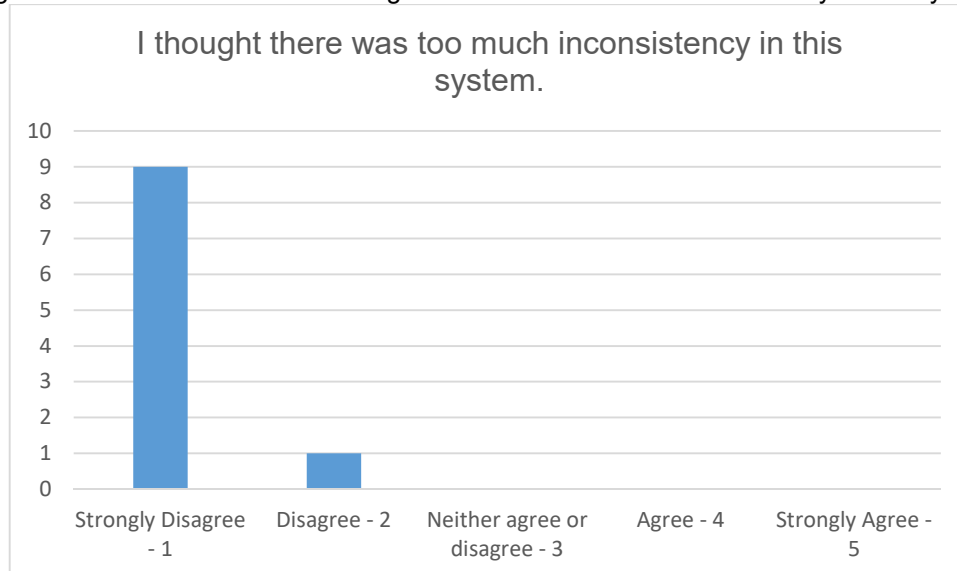
7. **I would imagine that most people would learn to use this system very quickly.**

Figure 6.9 shows the majority of participants agreeing with the statement. The average score for this question was 4.8.
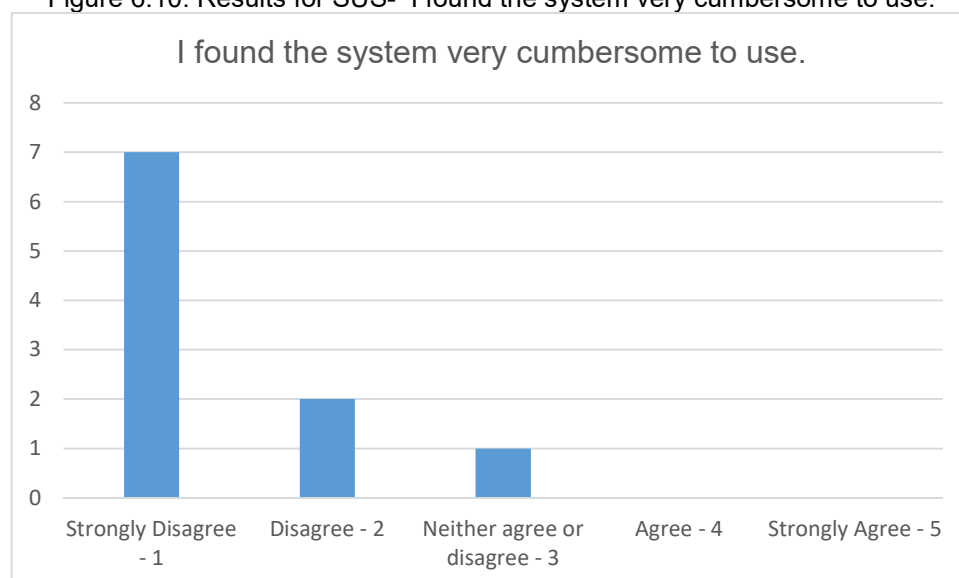
Figure 6.9: Results for SUS - I would imagine that most people would learn to use this system very quickly.
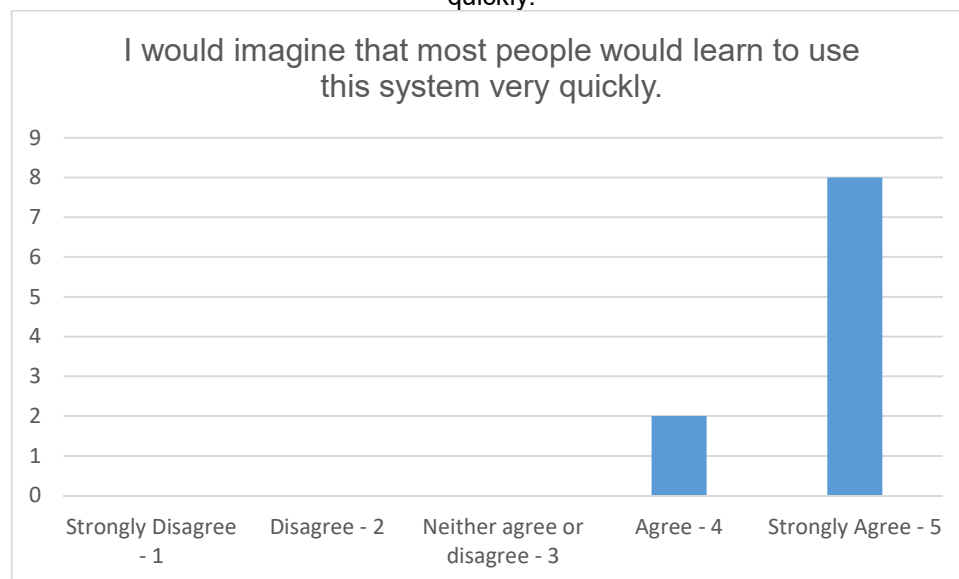
8. I found the system very cumbersome to use.
Figure 6.10 shows the participants response to the statement. The average score for this question was 1.5.
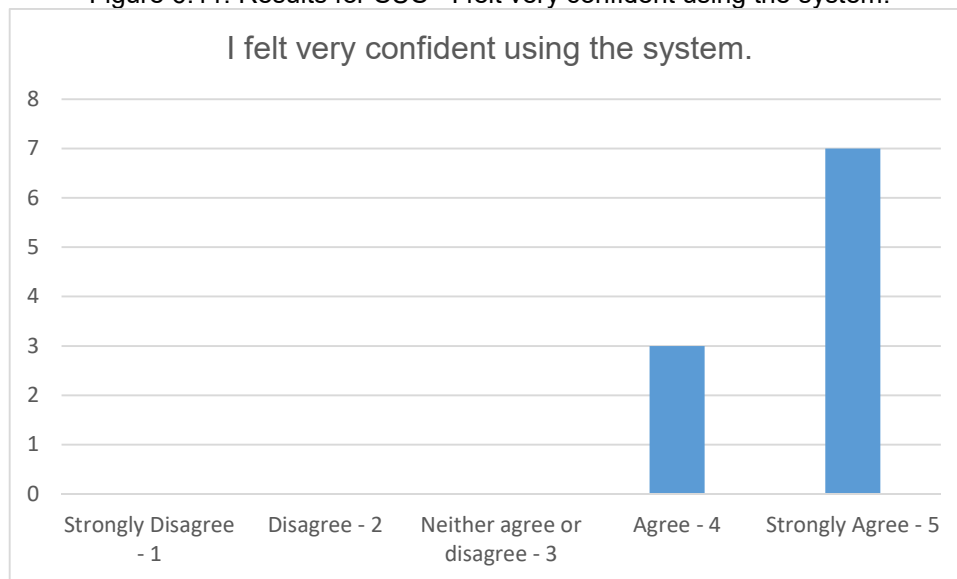
Figure 6.10: Results for SUS- I found the system very cumbersome to use.

9. I felt very confident using the system.

Figure 6.11 shows the majority of participants agreeing with the statement. The average score for this question was 4.7.
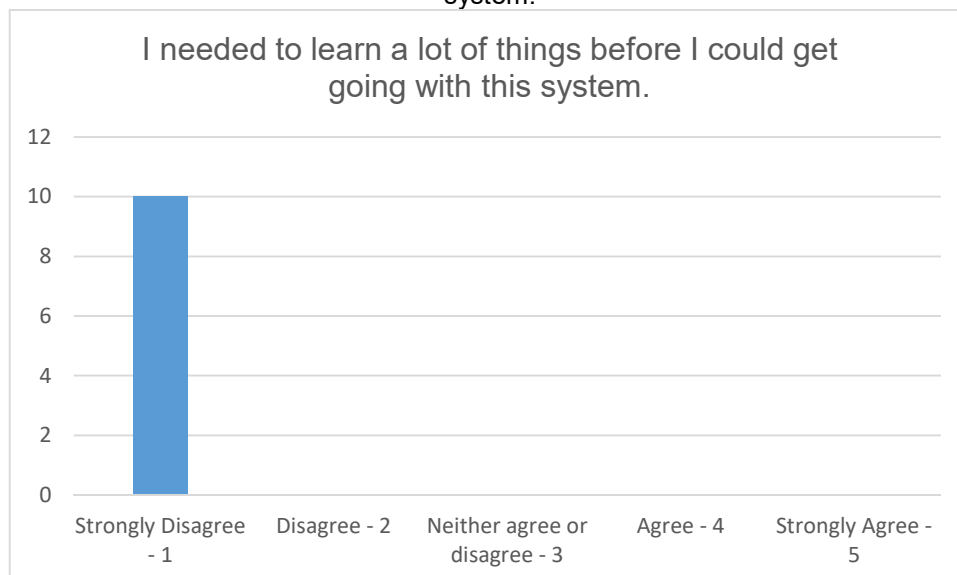
Figure 6.11: Results for SUS - I felt very confident using the system.

10. I needed to learn a lot of things before I could get going with this system.
Figure 6.12 shows that all participants strongly disagreed with the statement, therefore making the average score 1.

Figure 6.12: Results for SUS - I needed to learn a lot of things before I could get going with this system.

6.2.2. Feasibility Survey

Generally, participants ranked the statements in the feasibility study highly, with every question, apart from one, having an average between four and five, this is between agree and strongly agree. When asked, eight out of 10 participants strongly agreed they were able to tailor the app to suit their chosen habit and the remaining two participants agreed with the statement. The statement that had an average score below four was question five, about the timings of the notifications. This is investigated later in the chapter.

The overall average from all of the participants for all of the questions is 4.375 out of five. Figure 6.13 shows the breakdown of all of the average scores for every question.

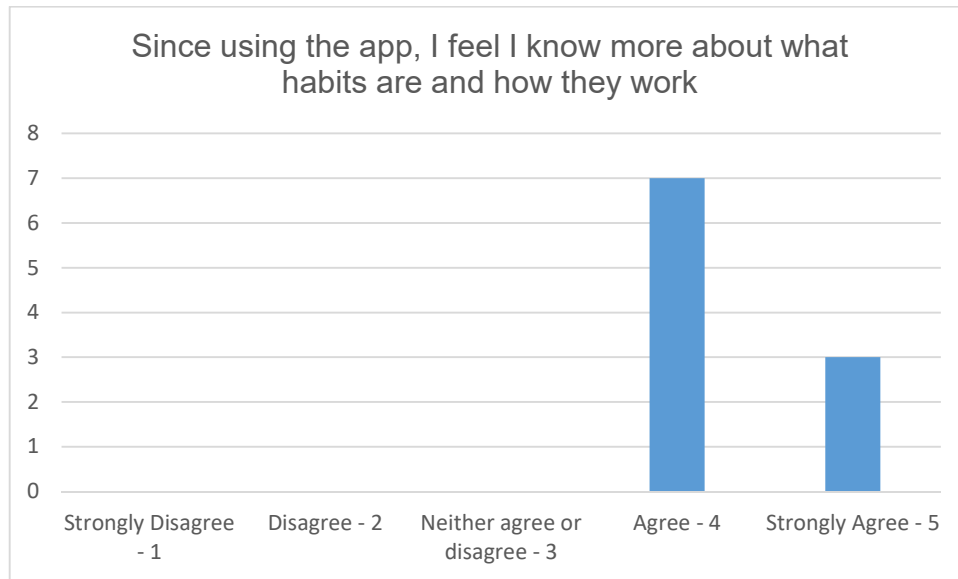Figure 6.13: Feasibility study average score breakdown
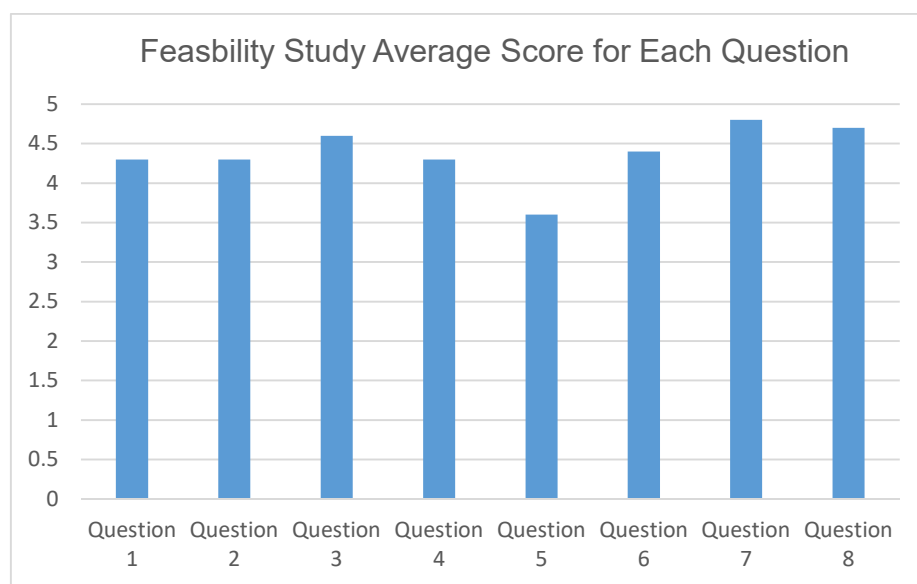
The following graphs show the distribution of answers for each question along with their averages.

1. Since using the app, I feel I know more about what habits are and how they work

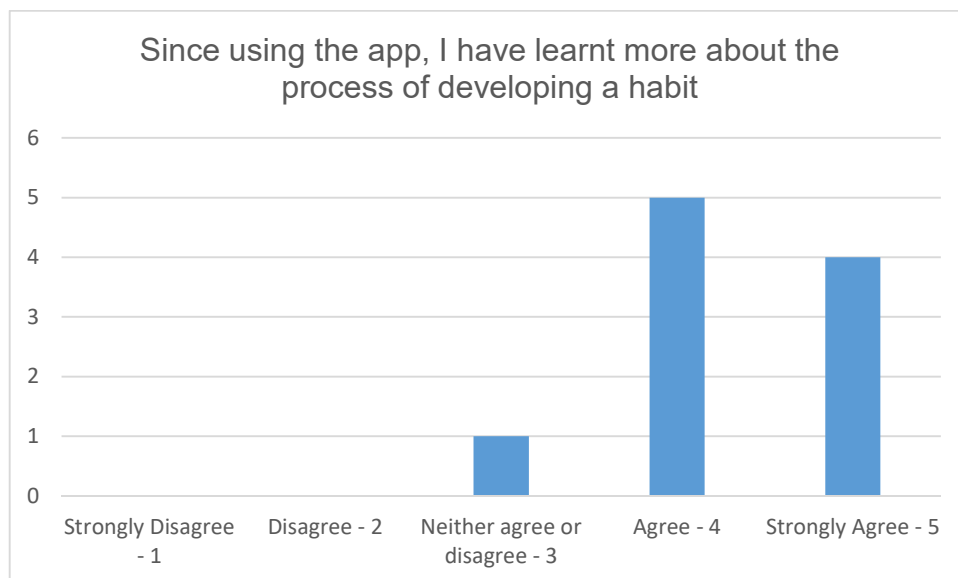Figure 6.14 shows the participants response to the statement. The average score for this question was 4.3.

Figure 6.14: Results for feasibility study - Since using the app, I feel I know more about what habits are and how they work.

Since using the app, I feel I know more about what habits are and how they work

2. **Since using the app, I have learnt more about the process of developing a habit**

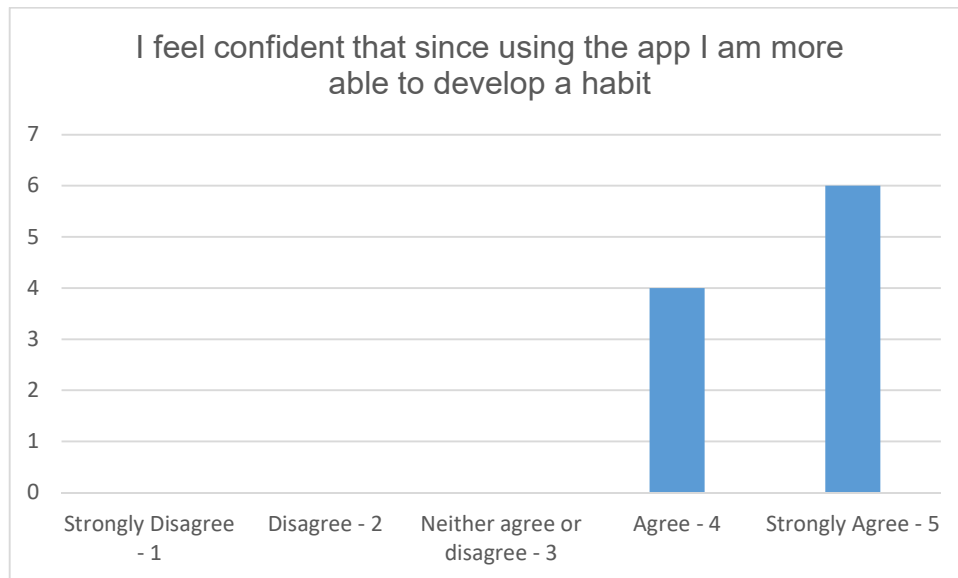Figure 6.15 shows the participants response to the statement. The average score for this question was 4.3.

Figure 6.15: Results for feasibility study - Since using the app, I have learnt more about the process of developing a habit.

Since using the app, I have learnt more about the process of developing a habit

3. **I feel confident that since using the app I am more able to develop a habit**

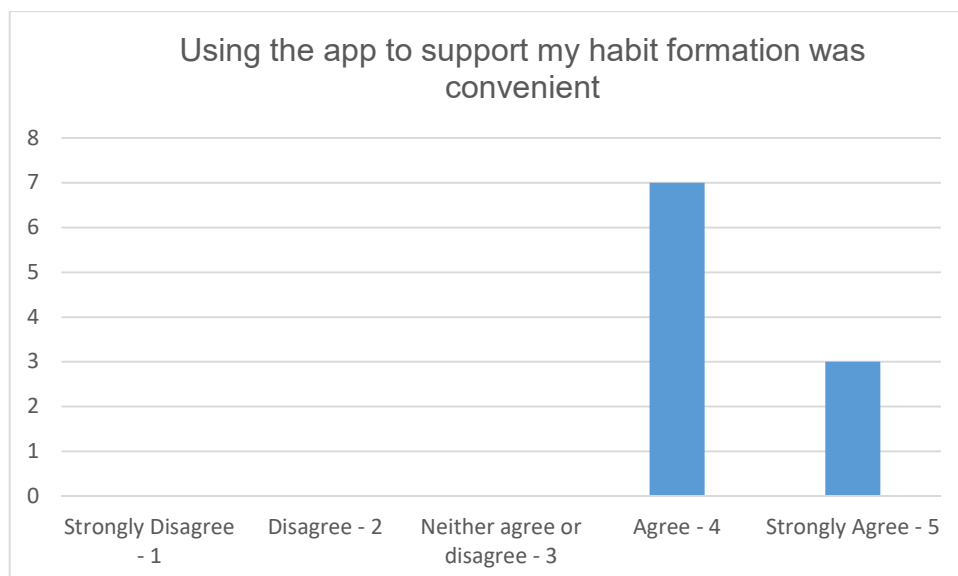Figure 6.16 shows the participants response to the statement. The average score for this question was 4.6.

Figure 6.16: Results for feasibility study - I feel confident that since using the app I am more able to develop a habit.

4. Using the app to support my habit formation was convenient

Figure 6.17 shows the participants response to the statement. The average score for this question was 4.3.
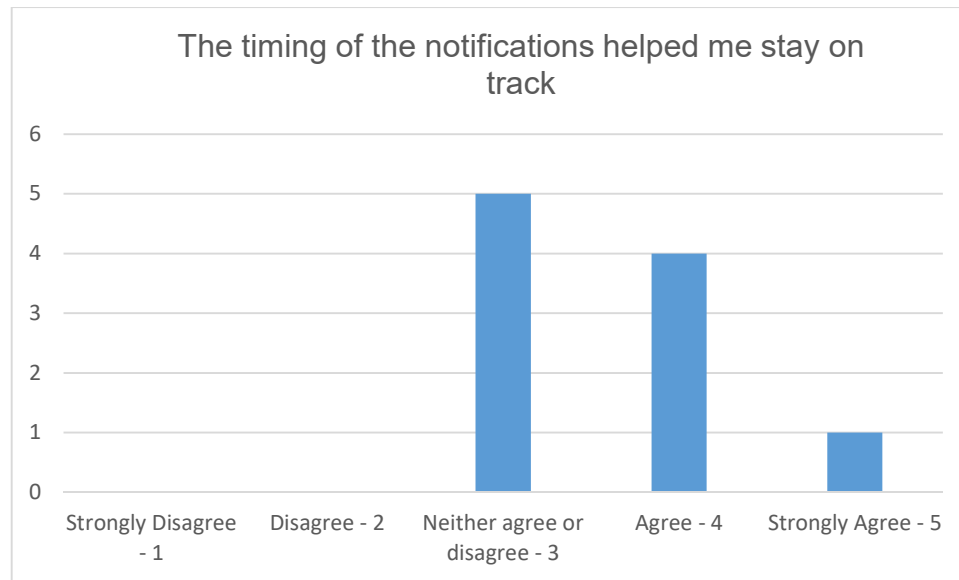
Figure 6.17: Results for feasibility study - Using the app to support my habit formation was convenient.

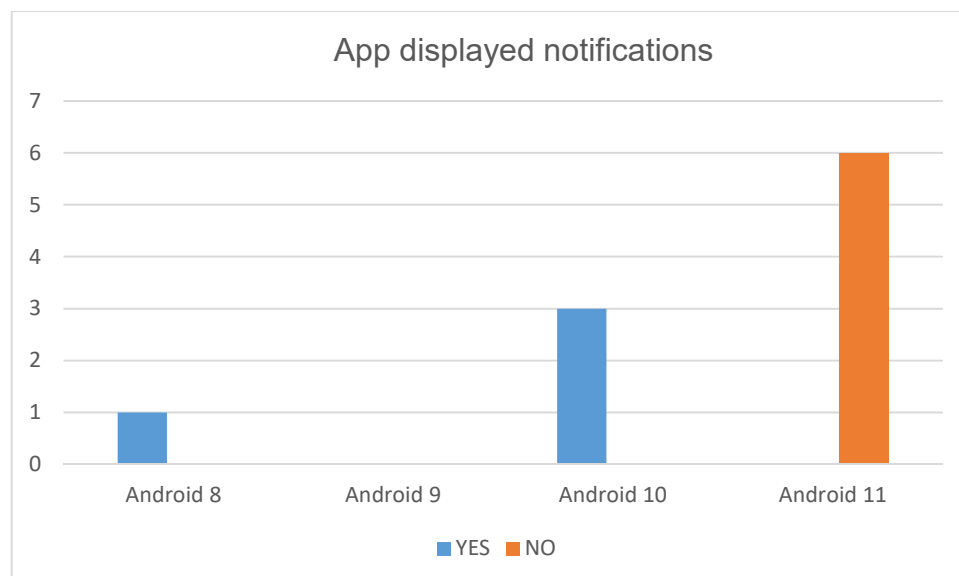## 5. The timing of the notifications helped me stay on track

Figure 6.18 shows the participants response to the statement. The average score for this question was 3.6.

Figure 6.18: Results for feasibility study - The timing of the notifications helped me stay on track

I investigated this and found that the notifications did not show at all for some people. In light of this, I looked into the correlation between the version of Android the participant was running and whether they got notifications. Also, there is the possibility that the user did not enable notifications during installation. Figure 6.19 shows the correlation between whether they received notifications and the Android software version their device was running.

Figure 6.19: Correlation between Android version and whether the participant received notifications

6.   The design of the app was appealing and made me more likely to use it

Figure 6.20 shows the participants response to the statement. The average score for this question was 4.4.

Figure 6.20: Results for feasibility study - The design of the app was appealing and made me more likely to use it.
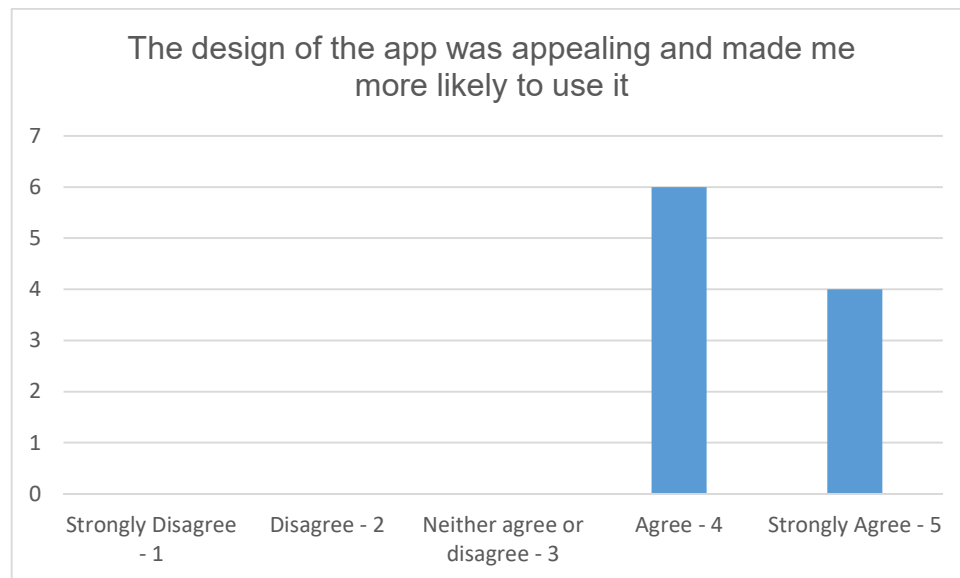
7.   I could tailor the app to suit my chosen habit.

Figure 6:21 shows the participants response to the statement. The average score for this question was 4.8.

Figure 6.21: Results for feasibility study - I could tailor the app to suit my chosen habit.

8. **The examples and explanations at each stage were beneficial in guiding me through the process**
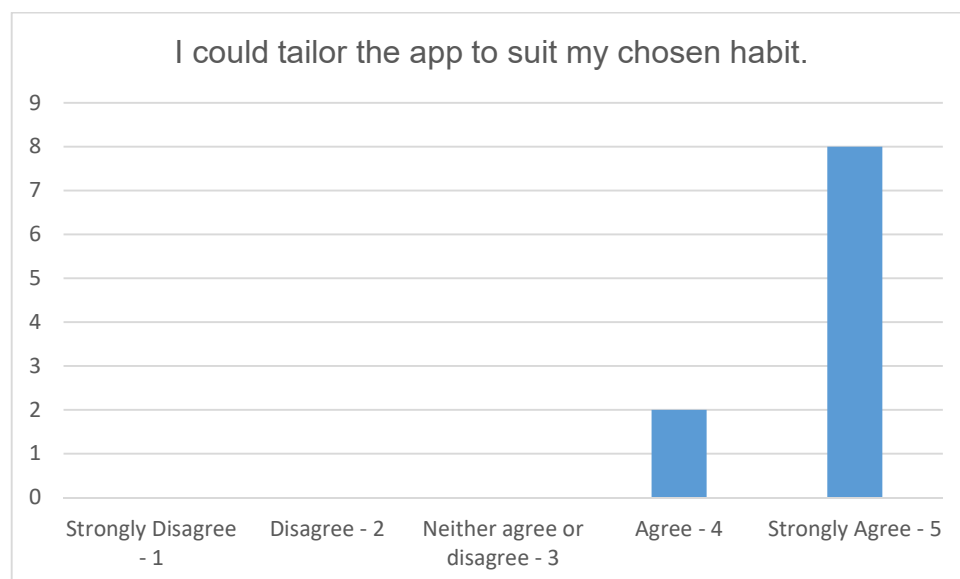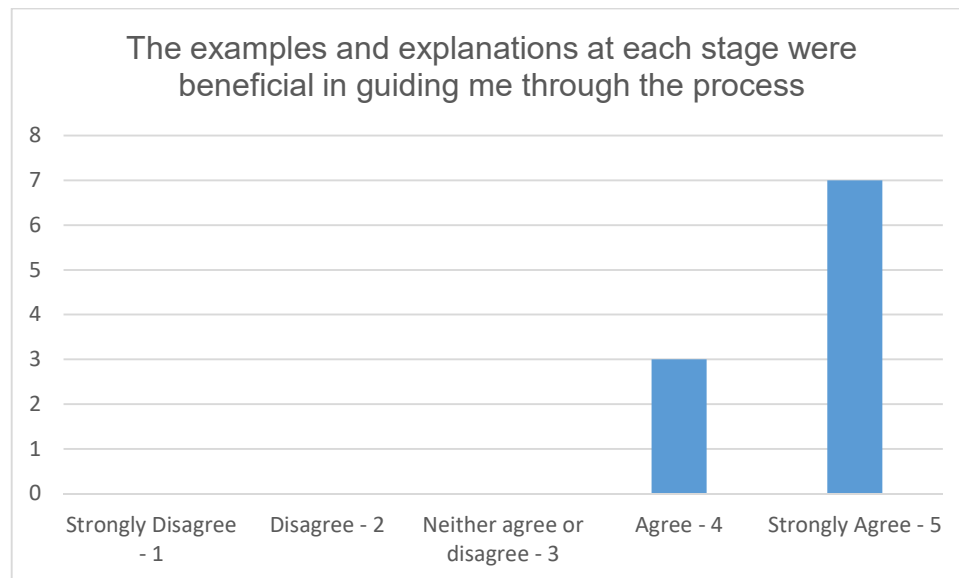
Figure 6.22 shows the participants response to the statement. The average score for this question was 4.7.

Figure 6.22: Results for feasibility study - The examples and explanations at each stage were beneficial in guiding me through the process.

6.2.3 Thematic Analysis:

I performed both top down and bottom up analysis in order to make full use of the data. Top down analysis looks for certain information in the data. It analyses the data that was specifically asked about and the interviewer took particular interest to. Topics of interest included the set-up process, the information it included and whether it was insightful as well as the participant's opinions on the notifications, specifically the timings of them. This helps to answer important questions surrounding the success of the prototype app and if key features need to be amended. Bottom up analysis looks at all of the other data, it focuses on the information that was not asked about, but was spoken about anyway. This is important because it can help to get a greater sense of how the participant truly felt about their experience with the app.

6.2.3.1 Top Down Analysis:

Theme: Value placed on notifications

This theme encapsulates user's opinions on notifications and how helpful they were. Two of the five interviewees did not receive notifications and were subsequently asked how the addition of notifications would affect their experience with the app instead.

Overall, there was a positive response to notifications with all that received them found them beneficial and those that did not, felt it would have enhanced their experience. The

participants did not feel an annoyance from the delivery of the notifications and liked that only one was received a day because it was not overwhelming.

Participant 3: "100% helped to complete the behaviour every day"

Participant 6: "would've made a difference"

Sub theme – response to random notification timings

The timings of the notifications vary from other habit formation apps as they are scheduled to occur after the user has performed the habit. This generally confused users at first but became clear once the app briefly explained the reasoning for this. Participants expressed the benefit from the timings because it reminded them to record that they had completed the behaviour in the tracker. If they had not completed the habit, participant said that it reminded them to try again tomorrow.

Participant 3: "would've been useful at the start to have them before I did my habit but after reading the information I understood why they were after, at random times in the morning"

Theme: Attitudes towards tracking

A divided opinion was found, with two participants really benefitting from the tracker and three participants not utilising it but one of which wished in hindsight they had. Those who benefitted from the tracker liked the helpful tips at the bottom of the page and the words of encouragement in the pop up message when either the YES or NO button was clicked. The participants who did not use the tracker said they had not tried using it but would consider using it in the future especially if there was a greater emphasis put on the importance of it.

Participant 1: "I thought tracking was a really good idea"

Participant 10: "I didn't feel like I needed it"

Sub theme – Opinions towards tracking design

Those who used the tracker provided benefitted from it but felt it could be improved and those who did not use the tracker detailed what would make them more likely to use it. The participants that did not use the tracker provided great insight into additional features that could encourage them to use it. Participant three explained that a feature that would allow the user to add comments about their experience everyday would be beneficial. Another participant liked the idea of being able to see some form of record showing all of the days that they completed the behaviour and which days they had not.

Participant 1: "Make the font bigger for the tips, I really liked those"

Participant 3: "diarise it"

Theme: Approach to set up

All of the participants interviewed were able to set up the app and follow the instructions given on the onboarding screens. The participants expressed their value of these screens and explained that it made navigating and using the app easier. Many participants liked the consistent design of the onboarding screens and benefitted from the pictures matching those

on the side bar menu. It was also mentioned the easy accessibility to these onboarding screens was helpful because the participants could return to it if needed.

Participant 1: "I found all of the links on the left hand side really easy and self-explanatory"

Participant 14: "found it very easy because it was in chronological order so I just followed each step"

Sub theme: Views on how informative the information was

The information showed to be of great value to the participants and the presentation of it ensured that it was not overwhelming. Many of the participants described the information as interesting and liked that it was separated so that it was not in large blocks of writing. This format made it easier to read and stay engaged. The repetition of information throughout the app was highly valued because the participants said the simple instructions and relevant information on each screen made it easier to follow.

Participant 3: "there is a lot of information but the layout of the app compliments it"

"I think without the information beforehand I would have been confused about the whole thing and it aided me to form my habit"

Participant 6: "information was in steps which was helpful and the information was interesting"

Participant 10: "interesting to read the information"

Participant 14: "finding that you should link a habit to another fully formed habit, I didn't know that and made habit formation easier"

Theme: Attitudes towards design of the app

Participants reported to working well with the design of the app and liked the colour scheme and the navigation. A common reflection on the app was about the bright colour scheme. Participants thought it complimented the concept of the app well and made it more enjoyable to use. The habit loop diagram on the home screen was highly valued because it reminded the user of the process straight away without having to reread anything. The participants stated that the consistency in the design made initial use of the app easier and described the information as clear and of reasonable font, size and colour.

Participant 1: "I found all of the links on the left hand side really easy and self-explanatory"

"Like idea of the habit loop being shown and the visual representation of it when you logged"

Participant 3: "design was very professional"

Participant 6: "attractive", "happy colours", "easy to understand", "user-friendly"

Participant 14: "design was very bright and welcoming"

6.2.3.2 Bottom up Analysis:

Theme: Reflections on their habit development progress

Although not asked, many of the interviewees talked about their progress developing the habit and believed that they were already starting to form the habit even after five days.

Three of the participants explained that they still found themselves performing the behaviour days after the testing period. They detailed that they were conscious that after they performed their affiliated routine, they also needed to complete the new behaviour too and felt this process was becoming slightly more automatic. A few of the participants said they would continue to use the app because they felt the app had helped them to make significant progress in building their desired habit even in the short testing period.

Participant 1: "just for doing it for 5 five days, even now I have clearly got that, 'oh I need to do that', I feel like I've started to form the habit even in a matter of days"

Participant 3: "would use the app again"

Participant 10: "I always make the bed now even if I don't feel in the mood"

Conclusions

In this chapter, I have presented my findings from the three forms of evaluation my participants completed. In the next chapter, I will be discussing these findings and comparing them with the information gained from my research in the Background chapter.

7. Discussion

This chapter will investigate further into the findings presented in the previous chapter (Results and Evaluation) and compare them with the preliminary research found in the Background chapter.

Current technologies on the market have been shown to be ineffective at supporting habit formation [1] due to a dependence being formed on regimentally timed reminders in order to complete the behaviour. The aim of this project was to research and implement alternative methods of encouraging habit development in an Android app. The app developed used psychological theories and was heavily focused on the habit loop as well as informing users how habits work. This is because, it has been shown that merely knowing the theory behind habits can improve the chance of forming a habit [3]. Notifications were still implemented but they were scheduled to be delivered at random times when the user is likely to already completed the behaviour. This significantly reduces the chance for forming a reliance on the reminders because it askes the user whether they have done it rather than reminds them to do it. This indirect form of backup notification was recommended in a previous study to solve the problems current habit formation apps face [6].

7.1. Summary of key findings

The evaluation of the app found that overall participants liked the design of app and found it easy to use, scoring highly on the system usability survey. Participants reported after the use of the app they now knew more about habits, how they work and the process of developing them (see figures 6.14 and 6.15). Problems arose from the notification system because not all of the participants received them. However, the general consensus was positive although some participants were initially confused by the concept of receiving of notifications after completing the behaviour until the app explained the reasoning for this. Those who did not receive them thought it would have enhanced their experience but reported that the lack of them did not hinder their development. The delivery of information was well liked and

described as interesting and important, with the presentation done in a way that was not overwhelming. The tracking system had mixed reviews; some participants found it really beneficial whereas others did not believe it to be useful and did not use it.

7.2. Findings compared to research (Background chapter)

Justification for the indirect notifications came from design recommendations in a paper I read during my research [6]. A study found that regimentally timed notifications, used in current habit formation apps, created a reliance on the reminder rather than the development of the desired habit [1]. Therefore, based on this research, I created back-up notifications that were received after the user was predicted to complete the behaviour. This was based on the user's daily routine rather than a specific time. There was initial confusion with this concept among participants but this was mitigated by the explanation for this method. Once this was clarified and the users understood the reasoning, the feedback was positive and thus supported the previous research. However, notifications would need to be available on all tested devices and require further testing in order to firmly support this.

Research in the Background chapter showed the self-trackers were not an effective method of supporting event-based cues [7]. On the other hand, another study presented a design recommendation allowing the user to use post completion checks as some users can benefit from keeping track of their progress [6]. Consequently, I implemented a basic tracking system but did not place a heavy emphasis on it like in other apps. My study findings were of mixed opinions with some users benefitting from the tracker and others not viewing it important in their habit development. Therefore, this links with both of the studies because of the differing opinions. This contradiction can be explained by personal preferences and attitudes towards learning because everyone learns in different ways [32].

The habit loop that I learnt during my research [3], along with a basic explanation of it, was displayed on the home screen of the app to remind users of this process every time they used the app. Research shows that by understanding how the habit loop works, habits are subsequently easier to manipulate as they can be broken down into components [3]. My findings supported this because there was positive feedback surrounding the information provided and the repetition of seeing the loop every time the user logged in. All participants agreed that by using the app they felt more confident in their ability to develop a habit and felt more knowledgeable about what a habit is, how they work and the process of developing one.

Identifying a cue for the developing habit is one of the three components of the habit loop [3]. To make this task easier, a study recommended that the implementation of contextual cues where the cue is a routine that already occurs in your daily routine [6]. This makes the process of forming a habit easier and more manageable because it is just adding a behaviour onto something you already do rather than doing something completely from scratch [7]. My study showed that participants found these contextual cues helpful and felt as though it made developing their habit easier. This suggests it could be an effective method of identifying a cue but requires further testing to be certain.

During my review of the current research, I gained a general knowledge of keystone habits [3], including what they are and the importance of them. To present this information in the app, I added an explanation specifically about keystone habits on the resources page which many participants reported to have read. All of the examples I provided on the habit information edit screen were also keystone habits in the attempt to make users think of habits of that kind. Seven out of 10 participants strongly agreed that the examples and explanations were beneficial in guiding them through their habit development and the other three participants agreed with this statement. As a result, many of the habit's participants

chose to develop were keystone habits but more research and testing would be needed to determine whether that was related to the explanations and examples provided in the app.

7.3. Design Recommendations

This project suggests that to produce a usable app that has the potential to be effective at supporting habit formation it should (i) encourage the association with a pre-existing routine, (ii) break down the development into a step by step process with concise explanations and (iii) deliver randomly timed notifications.

i.   Encourage association with a pre-existing routine

It has been suggested that affiliating the desired habit with a routine that is already completed in your daily routine helps the formation of a new habit [7]. By asking the users to identify consistent routines in their day to day life, they are able to choose one to act as the contextual cue for the development of their new habit. Research suggests that trial and error is required [10] and therefore the app should encourage the user to try connecting the habit with different pre-existing routines in order to find the routine that conveniently fits with the desired behaviour.

ii.   Step-by-step process

Breaking the process of developing a habit down into components makes building a new habit easier [3]. Therefore, sectioning the app into these components and establishing a clear flow of how to use the app would benefit the users experience. These sections should be based on the components of the habit loop: cue, routine and reward. Each of these sections should provide explanations detailing the purpose of it and generally guiding the user through the process.

iii.   Randomly timed notifications

Randomising the timings of the notifications, reduces the chance of the user becoming reliant on the reminder because they cannot predict when the notification will be delivered. Notifications should be scheduled to come after the user is due to complete the behaviour. By asking the user if they have completed their behaviour instead of reminding the user to perform the behaviour, there is a lower chance of forming a dependency on the notification. However, this concept should be explained to the user in order for them to fully benefit from it. The reason for this is because other habit formation apps use time based reminders, consequently making a new approach confusing to the user.

The app created during this project is an example of how these recommendations could be implemented in practice.

7.4. Limitations and Future Work

This study was constraint by the length of the project work period. It takes 66 days on average to form a habit [2] and the duration of the entire project was 12 weeks therefore not allowing a 10-week study to test the effectiveness of the app in supporting habit formation. Consequently, only the usability and feasibility of the app could be tested over a period of

five days. Although this study provided a useful insight into the success of the prototype, future work would need to include further testing over a longer timeframe to determine this with a higher degree of certainty.

Ten participants, who varied in age and gender, completed the entire study. This sample size was sufficient for the study that was conducted as it provided basic feedback on the usability and feasibility of the app. However, to test the effectiveness and complete more complex evaluations such as whether the decision to develop a keystone habit was influenced by the explanations and examples of keystone habits, a larger sample size would be needed to achieve more accurate results. Furthermore, all participants were either friends or family members which could suggest possible bias. Therefore in the future, more participants would need to be recruited that were of no personal connection to the researcher.

Issues occurred with the deliverance of notification because of differences in notification functionality across different versions of Android. This resulted in multiple participants not receiving notifications during the study and therefore not being able to provide feedback on their usefulness. To overcome this, future work would need to ensure that rigorous testing was done before deployment on different Android Devices, ranging in make, model and Android version. A link was found between participants that did not receive the notifications and the Android software version they were running; all of the participants that did not receive notifications were running Android 11. Therefore, this issue could be a result of a change in permissions on the latest software update. However, further research is required to clarify this and find a solution to overcome it.

The app was restricted to Android devices due to the limited scope of the project. The time constraints and my inexperience creating an app meant that creating an app exclusively to Android was the most feasible option that would produce a high fidelity prototype. Future work would expand the accessibility of the app to IOS devices and the web.

7.4.1. Unforeseen Problems

Throughout the development of the app, a number of unpredicted problems were presented. The knowledge that problems would occur was anticipated and factored into the development timeframe (see Section 3.1, Figure 3.1). Detailed below are some examples of significant complications that hindered the development of the app and the solution used to overcome them.

Buttons

- Problem:
  The buttons did not click or direct the user to the right screen. This problem was early on in the development process but took three weeks to fully solve.
- Solution:
  Extensive research was done to solve this problem. Eventually, I worked out the side bar navigation mapping was incorrect and that fragments required different coding styles to activities and most of the documentation online was related to activities.

Tracking System

- Problem:
  There was not enough time to implement the complex tracking system I originally wanted due to error debugging.
- Solution:

The tracking system was an optional feature and therefore a complex tracking system was not essential. A tracking system was still implemented but the complexity of it was lowered to allow more time to work on core functionality.

Use of Fragments

- Problem:
  When I first started developing the app I was not aware that the style of code differed between fragments and activities and the documentation about this was limited.
- Solution:
  A lot of trial and error was used to realise this problem but once I understood the issue I was able to alter what I was researching online in order to get the results I desired.

7.4.2. Future Developments

In the future, the functionality of the app could be enhanced to further support users develop a habit. Time constraints limited the functionality of the current tracking system as detailed in Unforeseen Problems (see Section 7.4.1.). The tracking system could be improved to allow users to see whether they have performed the habit or not for each individual day. This could be done using a calendar with the days that the behaviour was completed to be set in a different colour. The tracker could also implement a feature allowing the user to write about their experiences throughout their habit formation journey.

Another potential feature that could be implemented in the future is the personalisation of the notifications. The user could input their particular timeframe for morning, afternoon and evening because different people have different daily routines. This would ensure that the notifications were delivered at a suitable time that was after the allotted time the user was supposed to complete the behaviour.

Conclusions

Overall, my study findings generally support the research presented in the Background chapter. However, factors such as the time constraints and sample size of the study justify the need for future work before this can be determined for certain. In the next chapter I will present my final conclusions that I have reached after undertaking this project.

8. Conclusion

The aim of this project was to create an Android app that supported the formation of habits using psychological theories to ensure it was not solely dependent on time based reminders. This would bridge the gap between psychological theories and current habit formation apps [1] [3] [6] [7] [8] [9] [10] [15]. In-depth research into this topic was carried out before the creation of the app and a study was conducted to evaluate the usability and feasibility of the app. The study found that overall participants interacted well with the app, finding it easy to use and benefitted from its information and functionality. Results showed the potential for supporting habit formation and participants reported to have gained further knowledge about what habits are and how they are formed.

This process taught me the ineffectiveness of current habit formation apps, the need to personalise habit development to fit into daily routines and the benefits of understanding the

habit loop before attempting to implement it. Habits make up 40 percent of our daily actions [16], therefore putting a great importance on the habits we chose to develop and maintain. Sustaining healthy habits, like keystone habits, can have significant, positive impacts in all aspects of life [3]. Therefore, this justifies the need for a technology that helps people to develop healthy habits. In the future, further testing is needed to determine the effectiveness of the app at supporting habit formation and additional functionality outside of the project's scope can be implemented to further aid user's progress.

9. Reflections

This project has been an extremely valuable learning experience. Not only has this project improved my technical skills, it has also advanced my researching skills and my time management. The development of these skills has helped me significantly throughout the progression of this project and are crucial in the software development sector.

Throughout this project I was able to practice and advance the Java skills I learnt during my previous years at University. I had no prior experience developing apps and therefore learning Android Studio was a continuous process in this project. Initially, I struggled getting to terms with the new software and underestimated how long it would take to learn. I spent a lot of time researching and following online tutorials. This helped me to learn the basics of Android Studio but when I began to develop more advanced features, these tutorials were not always relevant. Nevertheless, I have learnt the entirely new skill of app development during this project, which is very transferable and relevant in the workplace.

Time management was vital throughout this project because research and app development needed to done before testing could be started. Testing had to start at the beginning of week nine in order to have enough time to complete the study and evaluate the results. Therefore, the need to stick to the time plan I created at the start of the project and to be organised was imperative. I stuck closely to my plan and made numerous lists and trackers to ensure all milestones were met. I consistently stayed in contact with my supervisor with weekly meetings and emails which were extremely insightful and were essential for the progress of this project. The implementation of personal deadlines allowed me to manage my time to a high standard and not feel constantly overwhelmed. Advancements in my organisation and time management skills have progressed my personal development and can be easily transferred into the workplace.

NoSQL databases were a relevantly new concept to me at the start of this project because I have only had recent experience with them in one, third year, module, Large Scale Databases (CM3104). I used Firebase Firestore to store the user's data, which was new to me. The use of a NoSQL database was daunting at first and it took longer than anticipated to get my head around, and design a database that would work for the functionality of the app. After research into NoSQL databases and looking to Firebase's extensive documentation, I was able to design a database that was compatible with the app. The gained confidence creating and manipulating NoSQL databases has been invaluable and will allow future work with NoSQL to be done with ease and to a higher standard.

Upon reflection, I feel that I could have been more responsible relating to backing up my work to mitigate potential data loss. Luckily, I did not encounter any such issues but I am aware of the risk. I only performed a weekly back-up onto my Google Drive. A lot of advancements can be made in a week and any kind of data loss could have been catastrophic in terms of time management especially during the app's development. In the future, I would edit my documentation in Google Drive or One Drive to ensure that backups were always up to date due to their auto save functionality. I would also utilise GitHub to

back up any coding documents because it is quick to do and I have been using it continually throughout the course of my degree. I am extremely fortunate that I did not suffer any issues of data loss and in the future will certainly perform more frequent back-ups to mitigate any losses.

In conclusion, I chose an ambitious project that required in-depth research, development of a prototype, a study and an evaluation to be conducted over a 12-week period because I wanted to challenge myself. I set high standards in order to keep motivated and to get the most out of this experience. Developing an app was completely new to me which at times tested my dedication and determination but generally kept me interested throughout. The topic of habit formation fascinated me and is something I will continue to learn about after this project. Completing this project has been extremely rewarding, especially seeing my research turn into a high fidelity prototype. Deployment of the app to my friends and family for testing and receiving overall positive feedback made the stressful periods of the project worthwhile and gave me a huge sense of achievement.

10. Appendices
10.1. Appendix A: User Requirements

Functional Requirements:

MUST HAVE:

- FR1: The user must be able to enter their habit of choice with examples provided for guidance
  Acceptance Criteria:
    - The user is able to enter the habit they wish to develop
    - Examples are provided if the user is struggling to think of a suitable habit

- FR2: The user must be able to enter their pre-existing routine, prompted by examples
  Acceptance Criteria:
    - The user is able to enter multiple routines they already have in their daily life
    - Examples are provided to prompt the user

- FR3: The user must be able to view their chosen habit, the pre-existing routine they have affiliated it with and the timeframe of that routine on one page.
  Acceptance Criteria:
    - The user can view this in the "Habit Information" section found on the side bar.
- FR4: The user must be able to view all of the routines they have identified on one page.
  Acceptance Criteria:
    - The user can view all of the routines they have acknowledged in the "Routines" section found on the side bar

- FR5: The user must be able to enter motivations for developing their habit of choice
  Acceptance Criteria:
    - The user is able to input all of the reasons they have for developing the habit
    - Examples of common motivations are presented to aid the user

- FR6: The user must be able to view all identified motivations for forming the habit on one page.
  Acceptance Criteria:
    o The user can view all of the motivations identified in the "Motivations" section found on the side bar

- FR7: The user must be able to enter potential limitations in their development of the habit and their possible solutions.
  Acceptance Criteria:
    o The user is able to add potential limitations that could stop them developing the habit
    o The user is able to add multiple possible solutions to each limitation
    o Examples of common limitations and their solutions are presented to prompt the user.

- FR8: The user must be able to view all of the potential limitations they identified along with the possible solutions they presented on one page.
  Acceptance Criteria:
    o The user can view all of the limitations and their solutions in the "Limitations" section found on the side bar
    o The possible solutions are clearly grouped to the relevant limitation

- FR9: The user must have access to a page of resources, a combination of tips directly on the page and directions to specific external resources
  Acceptance Criteria:
    o The user can view resources in the "Resources" section found on the side bar
    o The user is able to see generic, basic information and tips on the app directly
    o The user is directed to external resources that go into more detail if the user wishes for additional information

SHOULD HAVE:

- FR6: The user should be able to input whether they have performed the habit on a specific day on the tracker.
  Acceptance Criteria:
    o The user is able to input whether they have performed the habit action each day using the tracker found in the "Self-tracker" section on the side bar.

- FR7: The user should be able to modify and delete any of the information they have provided at any time
  Acceptance Criteria:
    o All information inputted by the user should be able to be modified or deleted
    o The user should be able to modify or delete their data using the edit icon at the top right of every page containing their data.

- FR8: The user should be provided with basic background knowledge of habits before they are asked to input anything
  Acceptance Criteria:
    o When the user uses the app for the first time, they should be provided with basic information on habits and how the process of forming them works
    o The resources page should provide basic information about habits for the users to reference at any point on their journey

COULD HAVE:

- FR9: The user can view their progress in graphical form using the data from the tracker
  Acceptance Criteria:
  - o A line graph will show the user's tracker information

- FR10: The user is given a brief explanation of how to use the app
  Acceptance Criteria:
  - o When the user uses the app for the first time, they will be shown the key features of the app and how to use them

Non-Functional Requirements:

- Accuracy – The tracker needs to be accurate with the information inputted by the user
- Ease of use – The user must be able to user the app without any prior training
- Relevance – All information provided in the app must be relevant to process of habit formation.
- Intuitive – The app must be easy to navigate the allows the user to get to the page they desire without extensive knowledge or use of the app.
- Response – The app must update any changes made within one minute.
- Portability – The app will be available for Android 5.0 and above.

10.2. Appendix B: Use Cases

Use Case Number: UC1 - Add Habit	**Type:** Must Have
Goal: The user is able to input the habit they wish to develop after they have been provided with the relevant information and examples of habits. This habit is stored in the database.	
Basic Flow: Home screen –> Side bar navigation –> Habit information page –> Edit button -> "Make changes" button	
Related Use Cases: N/A	

Use Case Number: UC2 – View habit information	**Type:** Must Have

Goal: The user will be able to view the habit they have chosen to develop along with what pre-existing routine they have chosen to affiliate it with and the timeframe of this routine all on one page. All of this data will be retrieved from the database.
Basic Flow: Home screen -> Side bar navigation -> Habit information page
Related Use Cases: UC1 – The user must have defined a habit. UC3 – The user must have identified pre-existing routines in their daily life and the timeframe associated.

Use Case Number: UC3 – Add pre-existing routines	Type: Must Have
Goal: The user must be able to add any pre-existing routines in their daily life and the timeframe they usually occur. This should be accompanied with examples of routines to make it easier for the user. This information will be stored in the database so it can be accessed at any time.	
Basic Flow: Home screen –> Side bar navigation –> Routines –> Edit button –> "Make changes" button	
Related Use Cases: N/A	

Use Case Number: UC4 – View routines	Type: Must Have
Goal: The user must be able to view all of the routines they have identified on one screen. This will be retrieved from the database and formatted in bullet points with the correlating timeframe shown next to the routine.	
Basic Flow: Home screen –> Side bar navigation –> Routines	
Related Use Cases: UC3 – The user needs to have inputted the routines in order to view them.	

Use Case Number: UC5 – Add motivations	Type: Must Have
Goal: The user must be able to add reasons/motivations for developing the habit of their choosing. This will be added into the database so it can be retrieved when needed.	
Basic Flow: Home screen –> Side bar navigation –> Motivations –> Edit button –> "Make changes" button	
Related Use Cases: UC1 – The user needs to have selected a habit in order to suggest motivations for developing it.	

Use Case Number: UC6 – View motivations	Type: Must Have
Goal: The user must be able to view all of the motivations they have listed on one screen. This will be retrieved from the database and formatted in bullet points.	
Basic Flow: Home screen –> Side bar navigation –> Motivations	
Related Use Cases: UC5 – The user must have inputted motivations in order to view them.	

Use Case Number: UC7 – Add possible limitations and solutions	Type: Must Have
Goal: The user must be able to add potential limitations to them developing the habit and present solutions to possible solve or mitigate this. This data will be inserted into the database.	
Basic Flow: Home screen –> Side bar navigation –> Limitations –> Edit button –> "Make changes" button	
Related Use Cases:	

UC1 – The user needs to have selected a habit in order to suggest motivations for developing it.

Use Case Number: UC8 – View limitations and their solutions	Type: Must Have
Goal: The user must be able to view all of the limitations they have recognised along with the solutions the identified that could mitigate them. This will be retrieved from the database and will bullet point the limitations with secondary bullet point lists displaying the correlating solutions.	
Basic Flow: Home screen –> Side bar navigation –> Limitations	
Related Use Cases: UC7 – The user must have inputted their potential limitations and the possible solutions to them.	

Use Case Number: UC9 – View helpful resources	Type: Must Have
Goal: The user must be able to view helpful resources. The resources all be tips directly shown on the page and directions to external resources for additional, detailed information. The tips on the page will be in a question and answer format and external resources will be bullet pointed.	
Basic Flow: Home screen –> Side bar navigation –> Resources	
Related Use Cases: N/A	
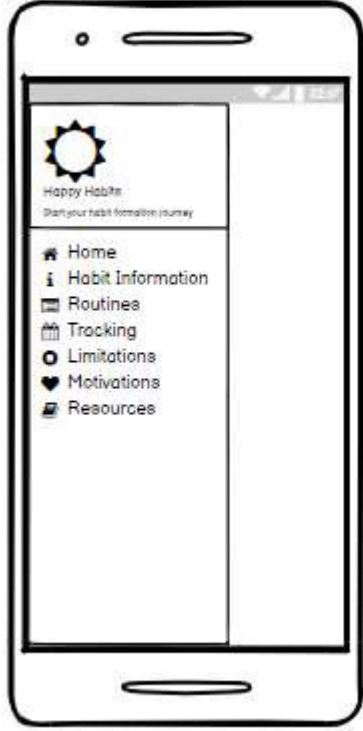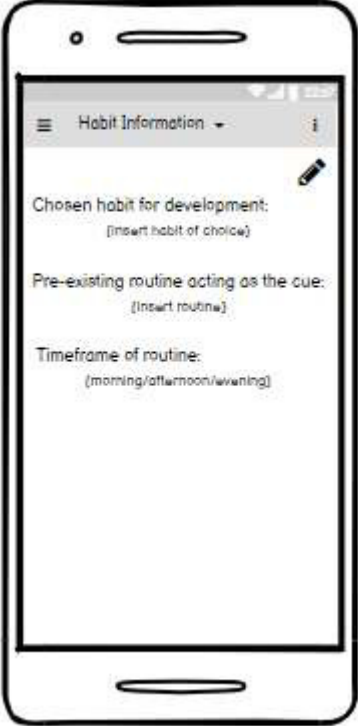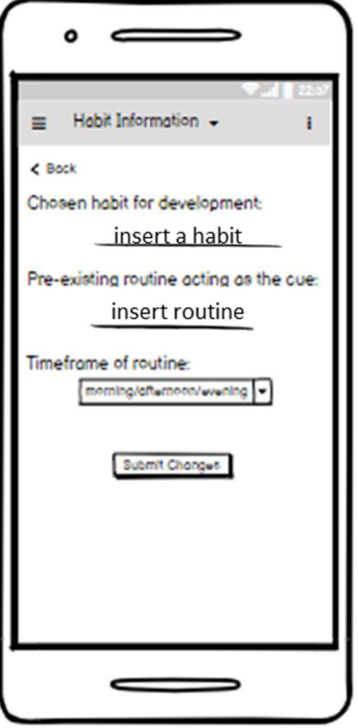
10.3. Appendix C: Initial Prototype Designs

	PT1: Home Page This is where the user will be directed to when they first open the app. The page will display the habit the have chosen to form, a randomly selected motivation they have inputted and a list of useful tips about habit formation. Relevant use case(s): N/A
	PT2: Side Bar Navigation This can be accessed by pressing the three lines in the top left corner of any page, a common format for apps. It will allow the user to access all of the pages by simply clicking on the one they wish to go to. Relevant use case(s): UC2, UC4, UC6, UC8, UC9 - The side bar is needed to be able to access the pages to view the information.

	PT3: Habit Information Screen This page will display all of the core information about the user's habit of choice. The Android icon for edit in the top right above the text, the typical placement of the icon. Pressing the edit icon allows the user to edit the habit information they have inputted. Relevant use case(s): UC1, UC2
	PT4: Habit Information Edit Screen This page allows the user to edit the habit information of the previous screen. The back button is placed in the typical location of the top left corner and the submit button is located generically under the editing options. Relevant use case(s): UC1

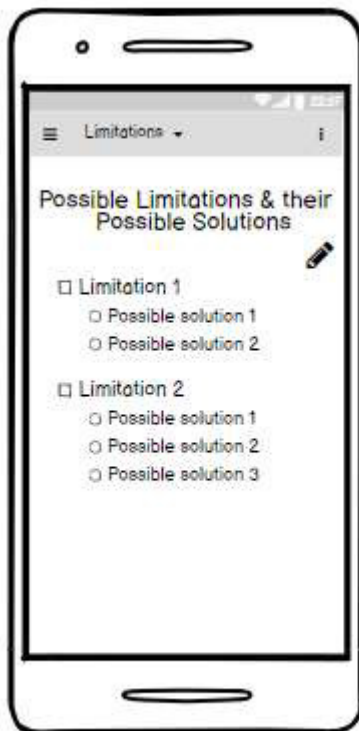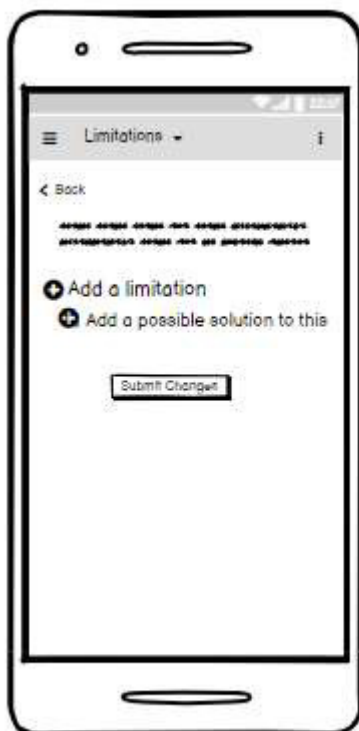|	
	PT5: Routines Screen This page will display all of the routines the user all does daily. The Android icon for edit in the top right above the text, the typical placement of the icon. Pressing the edit icon allows the user to add more routines. Relevant use case(s): UC3, UC4
	PT6: Routines Edit Screen This page allows the user to add routines they already perform daily. The back button is placed in the typical location of the top left corner and the submit button is located generically under the editing options. A drop down menu is provided for the timeframe for the timeframe input for ease for the user and consistency of answers. Relevant use case(s): UC3

	PT7: Motivations Screen This page will display all of the motivations the user has to develop their habit of choice. The Android icon for edit in the top right above the text, the typical placement of the icon. Pressing the edit icon allows the user to add more motivations. Relevant use case(s): UC5, UC6
	PT8: Motivations Edit Screen This page allows the user to add motivations they have to form their habit of choice. The back button is placed in the typical location of the top left corner and the submit button is located generically under the editing options. Relevant use case(s): UC5

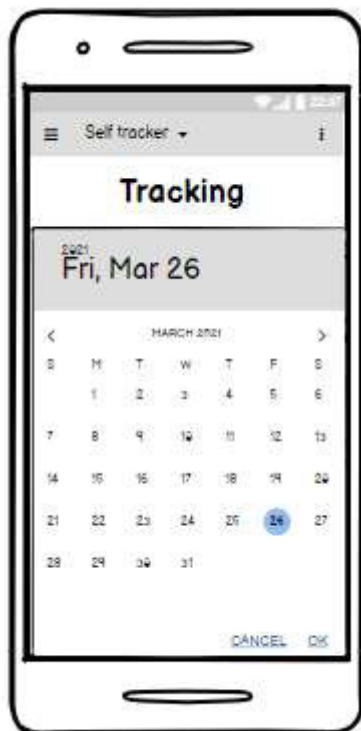|	
	PT9: Limitations Screen This page will display all of the limitations the user has pre-empted that could potentially hinder the development of their habit of choice along with possible solutions to mitigate the limitation before it occurs. The Android icon for edit in the top right above the text, the typical placement of the icon. Pressing the edit icon allows the user to add more limitations and possible solutions to them. Relevant use case(s): UC7, UC8
	PT10: Limitation Edit Screen This page allows the user to add potential limitations and their possible solutions to prevent factors challenging the formation of their habit. The back button is placed in the typical location of the top left corner and the submit button is located generically under the editing options. Relevant use case(s): UC7

	PT11: Resources Screen This screen displays a number of questions and answers that contains key information about the theory of habits and successful habit formation. The screen also includes external resources, such as book titles, for users that wish to gain a further knowledge about habits. Relevant use case(s): UC9
	PT12: Optional Tracking Screen This screen displays a calendar. The user will be able to select a specific a date and colour it if they have performed the habit that day. Pressing the ok button at the bottom of the screen will submit this change and keep that specific date coloured when the user returns to the screen. Relevant use case(s): N/A

10.4. Appendix D: Usability Evaluations of the Initial Prototype

Nielsen's 0-4 rating scale:

0 = I don't agree that this is a usability problem at all

1 = Cosmetic problem only: need not be fixed unless extra time is available on project

2 = Minor usability problem: fixing this should be given low priority

3 = Major usability problem: important to fix, so should be given high priority

4 = Usability catastrophe: imperative to fix this before product can be released

Heuristic Evaluations:

Heuristic Evaluation No: HE1	
Problem	No context explanation for the pages. For example, the routines page just says routines and doesn't explain that is about the routines that the user already performs in their daily routine.
Severity Rating	3
Relevant prototype number (PT)	PT3, PT4, PT5, PT6, PT7, PT8, PT9, PT10, PT12
Violated heuristics	Visibility of system status
Alternations	Add a context explanation about the page's purpose at the top of every page.

Heuristic Evaluation No: HE2	
Problem	The user is not able to delete or edit specific routine, motivations or limitations and solutions.
Severity Rating	2
Relevant prototype number (PT)	PT5, PT6, PT7, PT8, PT9, PT10

Violated heuristics	User control and freedom
Alternations	Add in delete functionality for any user input.

Heuristic Evaluation No: HE3	
Problem	There are no error messages.
Severity Rating	2
Relevant prototype number (PT)	PT4, PT6, PT8, PT10, PT12
Violated heuristics	Error prevention
Alternations	Add error messages for any submission of inputs.

Heuristic Evaluation No: HE4	
Problem	The user has to remember information from the onboarding screens as it is either not shown again in the main app or can only be found in the resources section.
Severity Rating	3
Relevant prototype number (PT)	PT3, PT4, PT5, PT6, PT7, PT8, PT9, PT10, PT12
Violated heuristics	Recognition rather than recall
Alternations	Add explanations on all relevant screens and provide all information shown on the onboarding screens in the main app.

Heuristic Evaluation No: HE5	
Problem	The aesthetic is not appealing or eye-catching for users. There is no colour scheme implemented.

Severity Rating	3
Relevant prototype number (PT)	PT1, PT2, PT3, PT4, PT5, PT6, PT7, PT8, PT9, PT10, PT11, PT12 - (All prototype screens)
Violated heuristics	Aesthetic and minimalist design
Alternations	Add a colour scheme and re-design the generic layout of the screens to be more eye-catching.

Heuristic Evaluation No: HE6	
Problem	There is no reference in the main app as to what the recommended flow through the pages is.
Severity Rating	2
Relevant prototype number (PT)	PT1
Violated heuristics	Help and documentation
Alternations	Add step by step guide of the recommended flow through the app.

C.R.A.P Evaluations:

C.R.A.P Evaluation No: C.R.A.P1	
Principle	CONTRAST
Comments	There is little contrast in the initial prototype. The title of the pages is slightly bigger than the text which is the only feature that would potential draw the user's eye. There is no contrast in colour as no colour scheme has been implemented and there is no variation in texture as no text has been set as bold.
Severity Rating	4
Relevant prototype number (PT)	PT1, PT2, PT3, PT4, PT5, PT6, PT7, PT8, PT9, PT10, PT11, PT12 - (All prototype screens)

Alternations	Implement a colour scheme throughout and set any key text as bold.

C.R.A.P Evaluation No: C.R.A.P2	
Principle	ALIGNMENT
Comments	Alignment is in the centre for the habit information page and it is left-centred for all of the other pages.
Severity Rating	1
Relevant prototype number (PT)	PT3, PT4
Alternations	Change the habit information page to conform to the same alignment structure as the other pages

C.R.A.P Evaluation No: C.R.A.P3	
Principle	REPETITION
Comments	Information about habit formation is not repeated in the pages for ease of use.
Severity Rating	3
Relevant prototype number (PT)	PT3, PT4, PT5, PT6, PT7, PT8, PT9, PT10
Alternations	Add relevant information on each page for the user does not have to recall any.

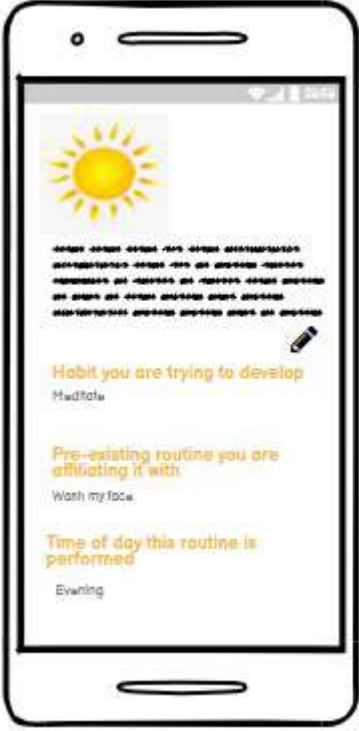| C.R.A.P Evaluation No: C.R.A.P4	
Principle	PROXIMITY
Problem	The edit pages are grouped with their corresponding page and the edit page is only accessible via the page where you view that information. The habit information edit page would be grouped with

	the routines page so the user could chose a routine they had already inputted.
Severity Rating	2
Relevant prototype number (PT)	PT4, PT5
Alternations	Add a dropdown menu for the routine input on the habit information page including all of the routines the user has added in the routine page.
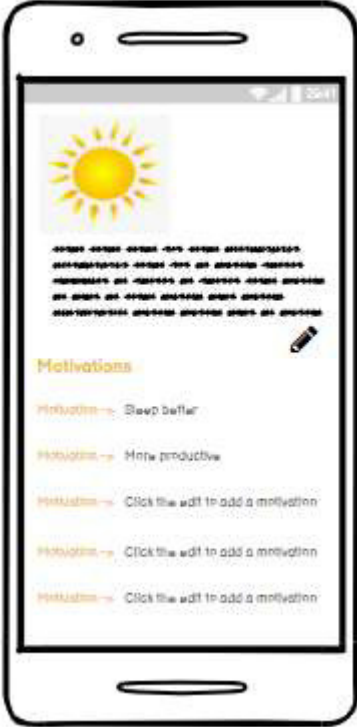
10.5. Appendix E: Final Prototype Designs

	Login Screen Usability Evaluation(s): N/A Improvements: A login system has been implemented. The enlarged logo is displayed and the user is able to enter their email and password or go to the create account if they do not have one.

Create Account Screen

Usability Evaluation(s): N/A

Improvements:

This page allows the user to create an account. A button in the top left gives the user to go back to the login. The logo is displayed like in other mock-ups in order to achieve consistency.

Home Screen

Usability Evaluation(s): HE5, HE6, C.R.A.P1, C.R.A.P3

Improvements:

The home screen in the initial prototype did not have much use so I changed its function to inform the user of key information about habits and refers them to the resources page if they want more information. The icon used in the side bar navigation is also shown next to this for consistency purposes.

There is also a large banner button that takes them to a getting started information. This is a replacement for the onboarding functionality.

	Routines Screen Usability Evaluation(s): HE1, HE2, HE4, HE5, C.R.A.P1, C.R.A.P3, C.R.A.P4 Improvements: The logo is shown in the top right hand corner and there is a block of text underneath explaining about routines. This applies the help and documentation C.R.A.P principle and the recognition rather than recall heuristic principle. The block text is in bold because it is important for the user to read and is provides contrast to the layout. This is followed by an edit button on and the routines the user has inputted. This layout is consistent with all of the pages that display user input.
	Routines Edit Screen Usability Evaluation(s): HE1, HE2, HE3, HE4, HE5, C.R.A.P1, C.R.A.P3 Improvements: There is bold block text to guide the user add a routine and provides examples. It is in bold to provide contrast and to show that it is important to read. This is followed by the edit text for the user to add their routine and a dropdown menu for the user to select the timeframe with ease. There is a back button at the top left of the screen to take them back to the routine screen and a make changes button at the button of the screen which commits any inputs the user has made. The colour scheme is applied to the button to make it stand out and for consistency. This layout is the same for all user input screens to ensure consistency throughout.

	Habit Information Screen
	Usability Evaluation(s): HE1, HE4, HE5, C.R.A.P1, C.R.A.P2, C.R.A.P3
	Improvements:
	The logo is shown in the top right hand corner and there is a block of text underneath giving information about habits. This applies the help and documentation C.R.A.P principle and the recognition rather than recall heuristic principle. The block text is in bold because it is important for the user to read and is provides contrast to the layout. This is followed by an edit button on and the habit information the user has inputted. This layout is consistent with all of the pages that display user input.
	Habit Information Edit Screen
	Usability Evaluation(s): HE1, HE3, HE4, HE5, C.A.R.P1, C.A.R.P2, C.A.R.P3, C.R.A.P4
	Improvements:
	There is bold block text to guide the user to choose a habit and provides examples. It is in bold to provide contrast and to show that it is important to read. This is followed by the edit text for the user to add their habit and a dropdown menu for the user to select a routine they have already inputted on the routine screen. There is a back button at the top left of the screen to take them back to the habit information screen and a make changes button at the button of the screen which commits any inputs the user has made. The colour scheme is applied to the button to make it stand out and for consistency. This layout is the same for all user input screens to ensure consistency throughout.

	Motivations Screen Usability Evaluation(s): HE1, HE2, HE4, HE5, C.R.A.P1, C.R.A.P3 Improvements: The logo is shown in the top right hand corner and there is a block of text underneath explaining about motivations and the purpose of them. This applies the help and documentation C.R.A.P principle and the recognition rather than recall heuristic principle. The block text is in bold because it is important for the user to read and is provides contrast to the layout. This is followed by an edit button on and the motivations the user has inputted. This layout is consistent with all of the pages that display user input.
	Motivations Edit Screen Usability Evaluation(s): HE1, HE2, HE3, HE4, HE5, C.R.A.P1, C.R.A.P3 Improvements: There is bold block text to guide the user to think of motivations for developing their habit and provides examples. It is in bold to provide contrast and to show that it is important to read. This is followed by the edit text for the user to add their motivations There is a back button at the top left of the screen to take them back to the motivations screen and a make changes button at the button of the screen which commits any inputs the user has made. The colour scheme is applied to the button to make it stand out and for consistency. This layout is the same for all user input screens to ensure consistency throughout.

	Limitations Screen
	Usability Evaluation(s): HE1, HE2, HE4, HE5, C.R.A.P1, C.R.A.P3 Improvements: The logo is shown in the top right hand corner and there is a block of text underneath explaining about the need to identify limitations and their possible solutions. This applies the help and documentation C.R.A.P principle and the recognition rather than recall heuristic principle. The block text is in bold because it is important for the user to read and is provides contrast to the layout. This is followed by an edit button on and the user's limitations and their correlating solutions. This layout is consistent with all of the pages that display user input.
	Limitations Edit Screen
	Usability Evaluation(s): HE1, HE2, HE3, HE4, HE5, C.R.A.P1, C.R.A.P3 Improvements: There is bold block text to guide the user to identify possible limitations they could face and provide possible solutions to these so that it does not hinder their habit development. It is in bold to provide contrast and to show that it is important to read. This is followed by edit texts for the user to add their limitation and a possible solution. There is a back button at the top left of the screen to take them back to the limitations screen and a make changes button at the button of the screen which commits any inputs the user has made. The colour scheme is applied to the button to make it stand out and for consistency. This layout is the same for all user input screens to ensure consistency throughout.

	Optional Tracker Screen Usability Evaluation(s): HE1, HE3, HE4, HE5, C.R.A.P1 Improvements: As this is an additional feature, as development of the app started I decided there was not enough time to implement a complicated tracking system like in the initial prototype. Therefore, I changed the mock-up to implement a more basic tracking system. I made the headings bold and applied the same colour scheme in order to achieve contrast, consistency and an aesthetic layout.
	Resources Screen Usability Evaluation(s): HE5, C.R.A.P1 Improvements: The only improved made to this page is to make the questions and headings bold and apply the colour scheme to them. This gives the page contrast and makes them stand out. It also achieves consistency by using the same colour scheme.

	Usability Evaluation(s): N/A
Are you sure you want to logout? YES NO	Improvements: The implementation of a login system meant that a logout page was also needed. It is simple and the logo achieves the consistent layout with the rest of the mock-ups.

10.6. Appendix F: System Usability Survey

System Usability Survey

Please read the statements clearly and mark the box that you think best reflects your opinion on it.

Please note that this survey is about the app itself and not the installation process.

	Strongly disagree 1	Disagree 2	Neither agree or disagree 3	Agree 4	Strongly agree 5
I think that I would like to use this system frequently.					
I found the system unnecessarily complex.					
I thought the system was easy to use.					
I think that I would need the support of a technical person to be able to use this					
I found the various functions in this system were well integrated.					
I thought there was too much inconsistency in this system.					
I would imagine that most people would learn to use this system very quickly.					
I found the system very cumbersome to use.					
I felt very confident using the system.					
I needed to learn a lot of things before I could get going with this system.					

10.7. Appendix G: Feasibility Survey

Feasibility Survey

Please read the statements clearly and mark the box that you think best reflects your opinion on it.

There is a section at the end to write any comments you have about the app, whether that is features you found helpful, any issues you had or any features you think would be useful to add.

	Strongly disagree 1	Disagree 2	Neither agree or disagree 3	Agree 4	Strongly agree 5
Since using the app, I feel I know more about what habits are and how they work					
Since using the app, I have learnt more about the process of developing a habit					
I feel confident that since using the app I am more able to develop a habit					
Using the app to support my habit formation was convenient					
The timing of the notifications helped me stay on track					
The design of the app was appealing and made me more likely to use it					
I could tailor the app to suit my chosen habit.					
The examples and explanations at each stage were beneficial in guiding me through the process					

Comments:

10.8. Appendix H: Semi-Structured Interview Guide Questions

- Could you talk me through your experience with the notification system and comment on the timings?
  - Could you predict the timings of the notification exactly?
  - Did you find this helpful?
  - How did you find the notification coming through after you should have completed the habit behaviour?
- On the first day of use, how did you find the setting up process?
  - Were you overwhelmed with information?
  - Was the flow through the app made clear?
  - Did you find the clear structure of flow helpful?
- Do you think the information provided was beneficial to the process of developing a habit?
  - Which parts did you find the most beneficial?
  - Did you read the resources? Were they helpful?
  - Did you learn something?
  - Do you think this supported your habit formation?
- How did use of the app fit into your daily routine?
  - How long did you use it for per day?
  - Did it fit conveniently into your day?
- Can you think of any additional features that you feel would be useful to have?
  - Why do you think they would be beneficial?
  - Did the lack of this feature hinder your development?
- Was recording your progress on the tracker beneficial?
  - Why?
- What were your overall impressions of the design of the app?
  - Could you navigate around the app easily?
  - Would change anything on the design front?
  - Any stand out features?
  - Any problematic features?
- What are your overall thoughts on the app?
  - Any concerns?
  - Any praise?

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