Cardiff University School of Computer Science and Informatics

A Study in the use of Mobile Devices for Supporting the Care of Elderly Patients

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Abstract

This report discusses the existing methodologies the NHS UK is currently using to help elderly people when they are discharged from hospital, and how these can be adapted and altered to relieve stresses on NHS resources. The report will discover and delve into real life stories and experiences of discharging patients from hospital, and how their experiences could have been improved.

Using Soft Systems Methodology modelling, the discharge process for elderly patients in hospitals will be examined, as well as methods for the patient to become independent quicker after major operations. Usability and functionality analysis of current mobile applications will be undertaken, specifically on apps that are used within a similar situation, to help see where technology could be used to help with the recovery period. Based on research and analysis, a set of requirements will be gathered, and a prototype designed. This will need to be appropriate for an elderly patient to use after they have been discharged from the hospital

The study will take patient confidentiality into consideration, as well as ensuring the mobile device does not need extensive interaction from the user. Future work to create the application with all its functionalities will need to be identified.

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1. Introduction

The NHS has been under a lot of pressure within recent years regarding the high bed occupancy rates that are necessary for the patient's safety. It has been found that 95% of beds in hospitals in England are occupied every day [1]. High bed occupancy levels can cause a significant increase of infection, as well as long waiting times in A&E. With the UK's ageing population, many of these patients are elderly (aged 65+). Therefore, this project aims to help elderly people when they're discharged from hospital, with the necessary precautions and planning in place. If the process of discharging patients is flawless, then there will be no unnecessary bed-blocking, and the patients will be happy that they are in the comfort of their own homes. The goal of this project is to provide the patient with a technological device that meets usability and functionality requirements that are necessary for an elderly user. The project will be approached by interviewing current patients and medical professionals, to help gather requirements for the study. Analysis of applications and technologies currently available will be undertaken, to help find gaps within the current market. The main target audience for the project will be elderly patients, who are recovering from operations.

1.1 Background Research

When determining the nature of the project, research areas were selected based on recent news articles. At this current moment in time (February 2017), the NHS has been called a "humanitarian crisis" [2]. Therefore, this project is very relevant and addresses a current issue. The NHS is struggling with a bed blocking crisis, which means that the hospitals are overwhelmed by the number of people needing care. Although this is not specific to elderly people, there are many elderly patients who are well enough to go home, however cannot do so due to lack of social care available. This results in them staying in the hospital longer than necessary, and prevents other people from having their hospital bed. Confirmation of this is apparent in the Royal Shrewsbury Hospital and Princess Royal Hospital in Telford, from an article in the Shropshire Star stating "On average patients are unnecessarily taking up the beds for seven days at a time. Some of the reasons for the delays in transfers are that there are no available beds in the community or because it takes time to arrange for Carers" [3].

This problem is apparent in all NHS hospitals across the UK, the pressure for hospital beds is continually becoming an issue, and pressure on the NHS and their available resources. Even after the introduction of a £5.3bn Better Care Fund to help local authorities invest in services to keep patients out of hospital, there has still been a rise in the number of delayed transfer cases. "The number of delayed transfers of care cases - when a patient is healthy enough to leave the hospital but is unable to do so - was meant to drop by 293,000. It went up by 185,000" [4].

It seems the NHS is doing everything they can with the resources and funds available to them, however it is clear that their current methodologies are not efficient in releasing healthy patients from hospitals.

From many articles read, it is clear that the elderly patients would do whatever they could to be discharged from hospital as quickly as possible, when they are happy and healthy enough to do so. However, due to the care for elderly people costing the NHS over 2.5 times more than the average 30-year old, it is very difficult for the NHS to provide the correct care that is necessary. This is a problem that will continue to grow

if nothing is done to help improve the system. Due to medical advances, people are living longer which results in an ageing population. Because of this, we will soon be a country where 1 in 5 people are over the age of 65. The chart below is taken from the BBC website. It shows how the ageing population is drastically increasing, and is predicted to increase to [5].

The UK's ageing population

% population aged 65 and over

Source: ONS   BBC
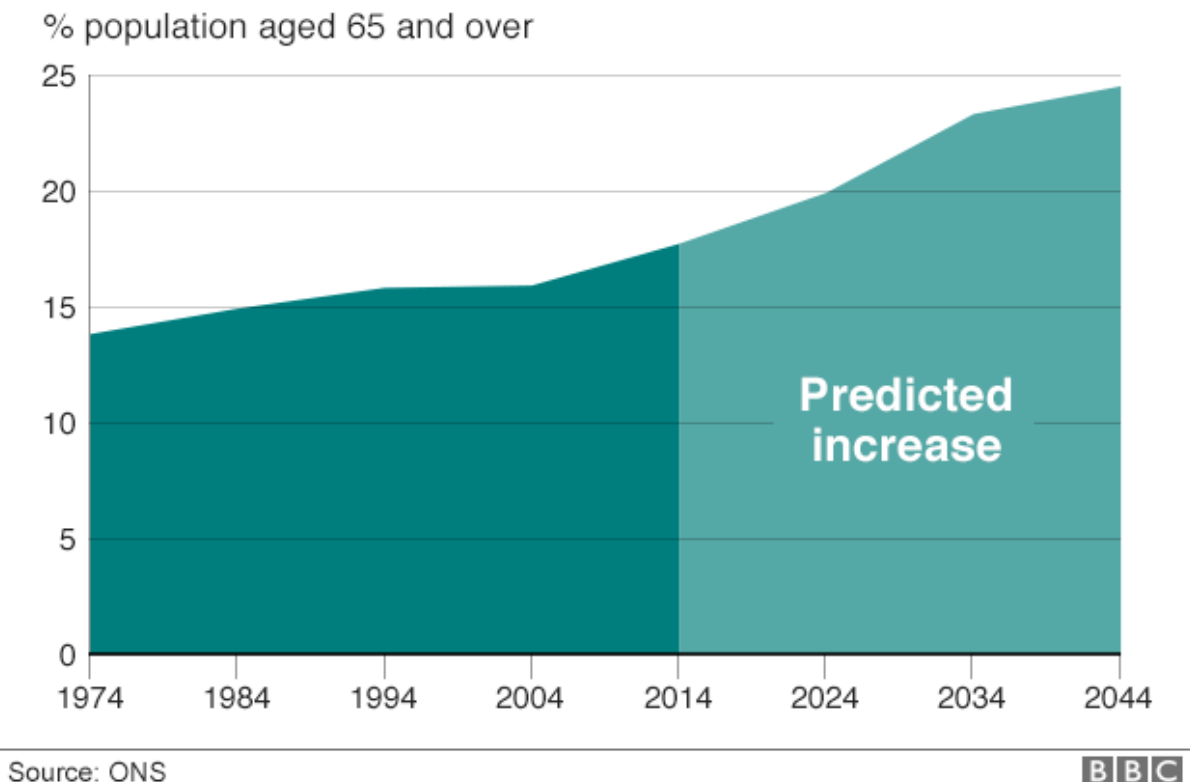
Figure 1: UK Ageing Population Chart [5]

With the increased demand for healthcare, and demands for A&E rising, it is in urgent need that the NHS services are improved, without the pressures being put on to the staff.

1.2 Current homecare technologies

To determine how to improve this problem, research into technologies that are currently available to elderly patients, needs to be undertaken. When researching this, there were no technologies attainable that are currently used by the NHS for home-care treatment aimed at elderly patients. However, there are several technologies created by independent companies, which users can choose to implement in their own homes.

Cornwall Smart Homes [6]

Cornwall Smart Homes is a home technology installed system that allows you to easily manage your heating, lighting, security and other home comforts from wherever you are. Although all the features of this system may not be relevant for the care of the elderly to live securely, Cornwall Smart Homes also have tailored solutions that has

been created to help relieve caregiver pressures. The types of features this may include are bed and chair occupancy sensors, alerts sent to caregiver in emergency situations, medicine administration and reminders.

GrandCare [7]

GrandCare is a suite of technologies designed to improve the care for seniors, monitored by healthcare professionals and caregivers. GrandCare provide different programs dependent on the user's healthcare needs, and allow the user to access their own 'Care Portal' from any Internet connected device. The types of support they provide are: Wireless activity sensors to monitor daily activities, remote activity sensor monitoring, wireless health devices, medication management tools, and full control over the user's content for caregivers.

ProSec Wellness Program [8]

ProSec allows family members or caregivers to monitor their elderly loved ones using intelligent sensors. This allows them to monitor their activity, such as how much time is spent in bed/on the sofa. It identifies any anomalies that may signify a problem. This is a great program for users who cannot afford assisted living. It also has a fall detection system that notifies the family/caregiver, even if the individual is unable to activate the button themselves.

Independa [9]

Independa is a smart TV technology that reminds users to take their medicine, and updates family members. Family members can set alerts for doctors' appointments and when to take medications. This allows family members to care for their loved ones, via their smartphone.

These home-care technologies seem to have some good qualities to them, however they all include an expense. Also, unless it is widely used by many patients, it will be very difficult to get social workers/district nurses to use it, as it will waste more time providing them with the training for the specific system, for just one of their patients to use it. These systems are good for individuals who are willing to use it for themselves and between their family members, however it is not appropriate for them to be integrated with the NHS, as it will cause unnecessary training and costs that not all users will be able to afford.

Based upon these technologies, further research will be taken into more specific mobile applications that could be used, without much expense and training required.

1.3 Aims and Objectives

The three mains areas this project will focus on is: research into technologies that help users measure their vitals, keep track of mobility, and remind users to take their medication. Based on current research and findings, these areas are the most relevant features for users who have recently been discharged from hospitals.

Apps for tracking mobility

There are currently no specific applications available for tracking movement around homes. There are apps that allow you to monitor how far you have walked, however they only work if you have travelled far distances – rather than just walking around the house. These apps are better for adults who are trying to measure their fitness levels. The type of feature we need for tracking mobility, is to check that the user has got out of bed for the day, or has not spent more than a specific number of hours sat in their chair all day. There are also no apps available that would alert a family member if a user has fallen, or if they are struggling to get out of the chair and need to ring their family member, GP or social worker. The most appropriate apps relevant to this study are Fitbit (which involves a wearable tracker), and SHealth which is an application that monitors mobility and inactivity through a mobile application.

Apps for measuring vitals

There are many applications that allow you to track vital signs. However, a lot of them are inaccurate and are difficult to use. Some examples are Instant Heart Rate Monitor, Cardiio and SHealth. SHealth is comparatively the most accurate, and allows you to measure more than one vital sign. It allows you to view and track trends, and enter readings for your blood pressure and blood glucose measurements. The other two applications only allow you to measure your Heart Rate.

Medication reminder applications

There are many applications available on the Apple Store and Android Play Store that allow you to monitor and track your medications. A few examples are Med Helper Pro Pill Reminder, iTriage Health, Medisafe, Pill Reminder, and Pill Monitor. These applications have similar functionalities; therefore, the usability of these applications is the most appropriate way to assess which features would be preferable for an elderly user.

1.4 Structure of the Report

This section provides a brief discussion as to what will be covered in each chapter of the report.

In Chapter 2, coverage of the types of methodologies used for preliminary research needed for the study are discussed. This involves methodologies such as Soft Systems Methodology, and the reasoning behind why questionnaires and interviews were necessary for the study.

In Chapter 3, the methodologies for gathering the requirements are carried out. This involves an in-depth analysis of the interviews and questionnaires, and how these helped to create an extensive list of requirements for the prototype design. A heuristic evaluation and analysis of similar applications has been undertaken, which helps to determine areas for where this system can improve and develop current applications that are already available to install on smartphones.

In Chapter 4, more specific scenarios are determined, as to who the application would be created for. This is then followed by a Gap Analysis which helps to determine where current applications are missing applicable features. This results in a comprehensive

list of all the gathered requirements taken from all the methodologies and analysis completed in the previous chapters.

In Chapter 5, this is where the prototype design is created. Represented by wireframes, activity diagrams and use cases, the prototype is proposed. This is then followed by the prototype design, which determines and discusses how all the requirements have been met through the prototype.

In Chapter 6, the testing phase is completed. The testing period involves think aloud testing from users within the specified target audience. This is assessed, and evaluated against the product. A risk assessment is also included, to ensure all risks of the application are stated.

In Chapter 7, a discussion and detailed conclusion about how the project has developed, as well as the results from the methodologies used, the output of the research, and findings from the final product design. This chapter also revises the Soft Systems Methodology from Chapter 2, as well as a discussion about the future of the product.

Chapter 8 is a discussion about how well the project has gone for the author of the report. Discussions about areas that went well during the project, as well as identifying characteristics of problems that have been addressed.

Now that extensive research has been taken into discovering the aims and objectives for the project, and background research has been fully understood in chapter 1, the methodologies and requirements can now be gathered.

2. Methodology

Due to the nature of the project, the aim is to test the usability of relevant mobile applications, and how they can be improved and adapted to be of assistance to the elderly patient. Due to the complex nature of this, it has been decided to use Soft Systems Methodology to provide a framework to identify the factors that will satisfy the project objective.

2.1 Soft Systems Methodology

Soft Systems Methodology (SSM) is a concept used to represent ideas in a structured way that allows for analysis and problem-solving tailored to the project, which enables a way of thinking about reality. The method used for SSM is Brian Wilson's method. Wilson states that the SSM "supports the process of analysis of information requirements" [9] . This method is useful for the preliminary research of the project, to know what steps to take, as well gathering requirements for information to support the project. Using SSM will bring a greater understanding to satisfy the user's problems and requirements.

Alternative Methodologies
Before choosing to create a SSM model, research was taken into other methodologies that could be used in the project. Below is the discussion of the researched options:

Conceptual Modelling: Causal Loop Diagram

A causal loop diagram is used to visualise how different variables in a system are interrelated. This is created through positive and negative casual loops. This is not necessary for the current project, as the main necessity for a causal loop diagram would be to see the profitability of the project, whereas this project does not need to monitor profitability as a feature of investigation.

Dynamic Modelling: System Dynamics

Dynamic Modelling follows the conceptual modelling phase, and is used to visualise and create robust designs to help minimise the likelihood of unintended consequences. System Dynamics has features such as Stocks, Flows, Converters and Feedback Loops to represent the dynamics of the system at hand. Relationships between the features allow you to view how the project would function, however not what the project needs and entails. Dynamic modelling was decided against, as it is more important that requirements for the project are gathered, as well as an understanding of how the project will progress.

CATWOE
CATWOE is a mnemonic, and is the mechanism for testing the Root Definition, by using precise words to describe the system. The CATWOE helps to develop a richer, properly formed root definition. Each of the elements of the CATWOE must be identifiable within the Root Definition. Below is a definition of the CATWOE elements:

- Customer – *The recipient of the output of the transformation process*
- Actors – *Individuals who would do the activities on the Conceptual Model*
- Transformation – *The process itself; what systems/processes will be affected from the start to finish*

- Weltanschauung (World View) – *The specific "world view" that makes the transformation process meaningful*
- Owner – *The decision maker who has authority over the system defined. The owner can change the nature of the transformation process*
- Environment – *Significant features external to the system defined*

From this, a CATWOE can be derived, specific for the project. Definition of the T and the W are determined first, as these define the key activities within the system, which allow for determination of the CAO and E.

Transformation: *Provide support and care for elderly patients*

Weltanschauung: *Assessing current technological devices functionalities and usability, to help elderly patients recover quickly from an operation*

Now that the T and W have been defined, determination of the other elements can commence:

Customer: *Elderly patients*

Actors: *GP/Carer*

Owner: *NHS*

Environmental Constraints: *Accessibility and usability for all users*

Root Definition
Based on the CATWOE, the Root Definition (RD) can be determined. A RD should include all the elements from the CATWOE, however it is mandatory that it contains a statement of T and the belief of W in the definition. The RD must be only one sentence long, and must describe what the system is.

Below is the RD, developed from the CATWOE:

"An NHS owned system, operated by doctors and carers to provide support and independent care for elderly patients, by assessing current technological devices functionalities and usability to help the patient to recover quicker from an operation, whilst understanding that there may be accessibility constraints and issues with usability for all."

2.2 Conceptual Model

The Conceptual Model (CM) is built from the root definition, to help visually display the activities and their logical dependencies within the project. "The CM must be constructed from the words in the RD without recourse to the *specific* situation. Thus, the inclusion of activities and/or sets of activities within the CM must be defended against specific words or phrases within the RD" [10] .

There are several features of a conceptual model that will be explained below:

Arrows and activities:
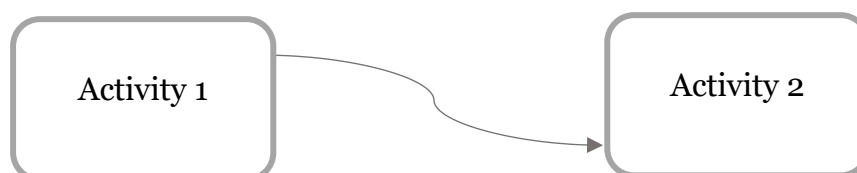
The arrows show the logical dependencies between the two activities. Therefore, Activity 2 is dependent on Activity 1 happening first.

C.A

Control Action: Used in situations when the system needs to address a situation.

C

Control: This shows where Control is required. If the arrow is pointing inwards, this means that it is taking action. If the control is facing outwards, this means notifying controllers from activities.

Activity Information

Activity Information: Identifies where the activities and its dependencies are monitored.

Below is the Conceptual Model:

Activity Information

Decide how to assess current technological devices

Take control action to ensure assessing of technological devices is done

C.A

Assess the impact on each activity

Determine accessibility and usability for all

Monitor System Performance

Assess current technological devices

Monitor the assessing of current technological devices

Decide how to react

Assemble the impact on each activity

C.A

Take control action to achieve expectations

Determine performance measurements

Notify each controller

c

Assess the achievement of providing support and care to elderly patients

Assemble activity constraint information

c

Monitor conformance

Determine GP/Carer performance expectations

Decide how to assess the achievement of providing support & care to elderly patients, to meet their requirements.

C.A

Take control action to ensure conformance

Take control action to ensure support & care is provided to elderly patients, so they are satisfied

C.A

c

Define GP

Define Carers

C.A

Take control action to match capabilities to requirements

Define the elderly patients requirements

Assess GP/Carers capabilities

Activity Information

Determine the capability required from each activity

Allocate resources to GP/ Carer

Monitor the match of capabilities to requirements

Activity Performance Information

2.3 Overview of approach to solution

To help determine what type of system/application is most appropriate for the target audience, research into pre-existing technologies has been undertaken, and how and who they would benefit.

Pre-existing technologies
Based on the pre-existing technologies discussed in the Chapter 1.2 Current homecare technologies, all the current technologies are either very expensive, or not usable for those who would need them. The aim of the project is to create a cheap system that would be easy to use for people who do not have technical know-how.

Ethical Approval
This project has formal ethical approval. The project needs ethical approval due to potentially gathering data about humans using interviews, questionnaires and publicly unavailable personal data.

Interviews
The target audience for the project is elderly patients who have recently been discharged from hospitals after a major operation. Therefore, two recently discharged patients have been identified, and will be interviewed to find out their opinion on the current NHS situation, and to see if they would be interested in an application that would help them with their recovery. Interviews were the preference for gathering information, as it ensures the user can get their point across easily, and allows the interviewer to base opinions on facial expressions and body language. A questionnaire would not have been beneficial for this type of research, since everyone's experiences are different, questions would be difficult to ask to get a wide range of results, and it may be difficult for the users to get their stories and experiences across via a questionnaire. The interview allows the user to think about their answers and express them in the form they prefer. It also allows for involvement and injection from the interviewer, to allow them to discuss further if they felt it was necessary for the study.

Questionnaires
A questionnaire has been created to be answered by anyone within the medical profession. A questionnaire was chosen instead of interviews, as it is known that medical professionals are busy people, and this way more responses can be gathered from a wide range of professionals, and ages. The users can range from medical students, nurses, GP's and other specialist doctors.

The questionnaire is created to try to understand what features, thought from a professional perspective, would be necessary for an application for elderly patients. Questions will be asked about their experiences with technology within medicine, and their opinions on the relationships and communication between the social care and hospital in the NHS. Gathering medical professional opinions will help to determine first-hand opinions about the NHS, rather than only relying on secondary resources such as news articles and TV debates. From the questionnaire, primary research will be gathered from real medical professionals, without there being any bias in the questions or answers.

Questionnaire Planning

To ensure a valid and correct outcome of the questionnaire is achieved, the main objectives that would provide desirable results, have been outlined:

a) To obtain primary information from medical professionals, to determine their experiences and opinions on the project, and to gain insight into a medical professional's response to after care for elderly patients

This objective is necessary, as the project author is not a medical professional. Aftercare details for patients are currently unknown, and first-hand experience of communications between Carers, nurses, social workers and doctors within the NHS is minimal. Therefore, understanding and gaining insight into a medical professional's opinion on these ideas will be useful for determining design requirements for the application.

b) To gain medical professional's opinions on design and functionality ideas for the application, and to understand whether they would use an application such as this in their profession.

This requirement is necessary to gather functionality and usability requirements for the application. A medical professional may not know exactly what an elderly person would want out of an application, but they will have a good idea as to what would be necessary during their aftercare. Regarding usability, a medical professional will know that the features of an app for themselves will be very different for an elderly patient, as they may have health conditions, sight issues, or hearing problems that could prevent them from using the app as effortlessly as your average patient. An understanding of what features the app would need from the medical professional perspective is essential to the study.

Design of the questionnaire

For the project, several different methods will be used to collect data, both secondary and primary. The questionnaire is a good way to initially gather some requirements for the designs of the prototypes. A range of opinions is hoped to be received and views from medical professionals with a range of experiences and ages. To create a questionnaire appropriate for purpose, several tools and methods have been researched into. The techniques are discussed below:

a) What style of question should be asked in the questionnaire?

The most important thing to consider when designing the questionnaire, is how the questions are delivered to the respondent, and if they are explicated well. From previous knowledge of creating and taking questionnaires, the questions need to be easy to understand and should be quick to answer. There should be a mixture of open and closed questions, as well as a mixture of methods for response e.g. multiple choice, dropdown or checkboxes. An open question will allow the respondent to share their opinions and experiences. These types of questions will be necessary when wanting to gain insight into their experiences and opinions, specifically on the communications within the NHS and social care. Closed questions will be used the most, as this allows for greater analysis of results, and does not steer respondents away from the question that is being asked. Closed questions will be used when there is not any need for elaboration, and a simple answer is required. Questions will be asked which allow the

respondents to choose several options, and provide comments on other responses they think may be necessary to the question.

To keep the respondents interested in the questionnaire, five different methods were used for answering questions. These were checkboxes, drop down boxes, multiple choice, and short and long answer text. Multiple choice questions were asked to identify which age group they fall into, and their relation to the medical field. These responses allow for easy analysis of information. These questions do not have many answers for users to choose from, therefore no vital information is lost from asking a multiple-choice question. A drop-down box was used for the respondents to choose from a series of options, to select how many years' experience they have had in the medical field. This is an easy way for the respondent to choose their relevant option, and looks more aesthetic in the design, as it does not mean that several options are shown on the main page of the questionnaire. Long and short answer texts are asked to encourage the respondents to share their experiences and provide a vision of how the NHS deals with the relevant type of issues. These questions help to determine which areas to focus on most throughout the study. These qualitative answers may be harder to analyse, but they provide the greatest understanding into the respondent's opinions. Checkboxes are the most commonly used style in the questionnaire. These are great to gather a large range of responses, and to understand where the main areas of focus should be. It allows the respondents to check as many options as they feel appropriate. These are closed questions, as the answers are provided for the responses, however there is an 'Other' option available for those who want to add in further comments on the question, which is available for an open-ended response.

b) How long should the questionnaire be?

As medical professionals tend to have a busy work lifestyle, it would be most appropriate for the questionnaire to be quick and effective. If the questionnaire is lengthy, and takes longer than 5 minutes, the respondents may get fed up and may not end up submitting the questionnaire. Due to this consideration, it was ensured that the information on each page was limited, and that the questions were split into sections. In the description before the questionnaire begins, it states that the questionnaire should not take more than 5-10 minutes. Due to most questions being closed, this takes a lot of time off the length of the questionnaire. When designing the questions, time to take the questions was considered, and any questions irrelevant to the study were eliminated.

c) What should the layout for the questionnaire be?

It was decided that there were 3 separate types of questions to ask: Demographics, Medical Experiences, and Technology. Therefore, questions were split into these three sections. In each section, a brief overview was given about why these questions were asked, and how they are relevant to the study. In each section, it was ensured that there were not too many similar and lengthy questions that the respondents could find exhausting to answer. In each section, there are no more than 7 questions. Most questions are closed, to allow for more responses.

d) What platform should the questionnaire be created on?

Research into available platforms that allow you to create free online questionnaires was taken. The options were narrowed down to SurveyMonkey, Google Forms and KwikSurveys. They all provided the option to create an online questionnaire that is easy to share with others. Through previous experiences of SurveyMonkey, awareness

that there are certain features and types of questions that SurveyMonkey expect you to pay for was taken into consideration. No boundaries were wanted throughout the study; therefore, this option was discounted. The author had no previous experience of KwikSurveys, however there was experience of Google Forms. Knowing that Google Forms are reliable, easy to use, and look professional, the use of Google Forms was decided, instead of wasting time learning how to create a questionnaire on KwikSurveys, especially when all the features needed were available on Google Forms. Through using Google Forms, a popular tool used and trusted by many, this would in return increase the number of respondents to the questionnaire.

Requirements

To gather the requirements, many different methodologies will be used. The use of a heuristic evaluation on similar current applications will be undertaken, to see which requirements are applicable, and how these are violating Nielsen's rules for Heuristics. This will help to determine requirements for the prototype. A Gap Analysis will also be undertaken to see where current gaps are in the market for applications, and how this can be applied to the elderly target audience.

Design and Testing

For the design and testing phase, a prototype software will be used to create dynamic wireframes of what the application should look like, and the functionalities it should adhere to. The design phase will involve creation of use cases, activity diagrams

Now that the planning for methodologies and research methods has been undertaken, requirements gathering can now commence.

3. Identifying Requirements

3.1 Interviews

<u>Interview template</u>

"This interview is to determine the undergoing problem that the healthcare industry is currently going through. This interview will ask several questions to users who have had trouble receiving social care after being discharged from hospitals, or have cared for people in this situation. If you need a question rephrasing or need me to explain a question further, please say."

Name of respondent:

Question 1: When you were discharged from hospital, were you provided with home care support from the NHS? If so, please explain the type of support and the quality of care you received.

This question was asked to find out what support the NHS gives to patients for their recovery, and to see if there is a difference in answers from both respondents.

Question 2: Before you were discharged from hospital, did you find yourself waiting around before you could be sent home? If so, how long were you waiting for?

This question was asked to see if there was a delay in discharge due to any complications with communication between staff, lack of beds in a respite care hospital, or lack of support for the patient when they are in their own homes.

Question 3: Did you ever feel you do not get enough support for your medical needs?

This broad question was asked to see if the interviewee was happy with the support they received from the NHS, regarding their own medical needs.

Question 4: Did you ever have trouble receiving care on time?

This question was asked to see if the NHS had to delay any appointments or operations due to high pressure.

Question 5: What was the most difficult task you found to do on your own, after being discharged from the hospital?

This question was asked to understand the most difficult task that the patient found to do alone, to see how the support in this area could be improved on.

Question 6: Do you think you would benefit from a system or application that would allow you to monitor your healthcare at home. For example, something that tracks your movement, allows you to monitor your vitals, and reminds you to take your medicine.

This question was asked to see if the patient would ever consider using technology in their home to help them recover or look after their own health on their own.

Question 7: Would you feel more at ease alone at home if you had something that would remind you when to pick up your prescriptions, and send medical information to your social Carer or GP if necessary?

This question was asked to find out if the patient would like medical reminders to keep them on top of their medications. It was also asked to see if the patient thought

it would be a good idea to send information to their GP, so they can keep an eye on their health throughout their recovery.

Question 8: Have you ever used any type of technology that allowed you to take care of your own medical needs?

This question was asked to find out if there were any technologies that are currently being used that had not already been researched, and to understand why and how the patient was using this currently.

Question 9: What is your opinion on the current strain the NHS is having in regard to lack of beds for patients?

This question was asked to discover different perspectives on the strain the NHS is having, especially from those who have recently used NHS services.

Question 10: Would you be willing to be contacted again to help provide further feedback, as this project progresses?

This question has been asked to gain the permission of the interviewee, for if they are needed for more discussions throughout the project.

3.2 Interview Analysis

Interviews with two elderly patients have taken place. They have been asked the above questions, with space to elaborate where necessary. The two interviewees have not been named, however there is a brief description of them:

Interviewee No.1 – Male, Hip Operation, Age 78 when operation took place

Interviewee No.2 – Female, Knee Operation, Age 79 when operation took place

Please see appendix for the interview responses.

Question 1: *When you were discharged from hospital, were you provided with home care support from the NHS? If so, please explain the type of support and the quality of care you received.*

Both respondents had very different stories to tell. Interviewee No.1 received social care after being discharged from hospital, however Interviewee No.2 did not receive any care (although was supposed to). Interviewee No.1 thought that the homecare provided was very good but could tell that the NHS staff were under time pressures, and noticed that the Carers rarely came from nearby locations. This is like the situation for Interviewee No.2, as she was offered respite care in an area that is too far away from her home for her to want to be moved to. This shows that there is a strain on resources, in which they need to use staff from further areas than would be in the usual district of nurses. Interviewee No.2 seemed to have struggles with receiving the care in appropriate time. She did enquire about receiving care for help in and out of the shower, but by the time they managed to gather Carers to help, it was too late, and Interviewee No.2 could already get into the shower herself. Interviewee No.2 said it would have been very difficult if she did not have family members to help her out. Interviewee No.1 had the most trouble with the physiotherapy department, in which

he did not receive much care at all. This meant he was unable to go outside of his house for at least 6 weeks, which caused him to feel very isolated and restricted.

Question 2: *Before you were discharged from hospital, did you find yourself waiting around before you could be sent home? If so, how long were you waiting for?*

Both interviewees had the same response in which they were not kept informed about when they could be discharged from the hospital. They both felt they should have known exactly when this should have been, and that communication was poor on this front. Both interviewees were kept in hospital longer than they had previously expected.

Question 3: *Did you ever feel you do not get enough support for your medical needs?*

Interviewee No.1 felt that the support at home was good, however he was aware that the helpers were struggling with their workload. As for the physiotherapy, he felt that the communication between the departments in the NHS was disorganised, as they did not pass his information on, therefore he did not receive the physiotherapy care that he was entitled to. Interviewee No.2 agreed that the communication was poor, especially when things need to be done on weekends. She made it clear that nothing happens on weekends, so if you are expecting something on the Friday, and it does not get done, you would have to wait two extra days until the Monday. She had a very different opinion to Interviewee No.1 regarding support, as she did not receive any support at all when she was at home.

Question 4: *Did you ever have trouble receiving care on time?*

Interviewee No.2 did not receive social care, however the physiotherapy care was fine. Interviewee No.1 said that the social workers were not always on time, but they always turned up, even if they were an hour late.

Question 5: *What was the most difficult task you found to do on your own, after being discharged from the hospital?*

Both Interviewee's had different responses. Interviewee No.1 said he had the most difficulty getting his trousers on. Interviewee No.2 said the most difficult task was trying to get up the stairs with crutches.

Question 6: *Do you think you would benefit from a system or application that would allow you to monitor your healthcare at home. For example, something that tracks your movement, allows you to monitor your vitals, and reminds you to take your medicine.*

Interviewee No.2 did not think this would be something she would like. However, she had enquired about a technology that would allow her to alert someone when she is in pain, however did not follow through with the purchase, mainly due to the high expense. Interviewee No.1 felt it would not be great shortly after the operation, because

it would be quite difficult to use if you still felt ill after the operation. He was apprehensive, however thought the idea may help when you are gradually getting better from the operation.

Question 7: *Would you feel more at ease alone at home if you had something that would remind you when to pick up your prescriptions, and send medical information to your social Carer or GP if necessary?*

Both Interviewees had very different responses. Interviewee No.1 said 'Yes', however Interviewee No.2 said "Not necessarily".

Question 8: *Have you ever used any type of technology that allowed you to take care of your own medical needs?*

Neither of the Interviewee's had used any sort of technology that allowed them to take care of their medical needs, and stated that it had never been offered to them.

Question 9: *What is your opinion on the current strain the NHS is having in regard to lack of beds for patients?*

Interviewee No.1 does not believe this is a current issue, he stated that this has always been an issue. He had 6 cancelled appointments for his operation, which he believes was due to the strain on resources the NHS is going through. He believes this has been an issue for a while, but it is currently growing more and more, and is being highlighted more in the media. Interviewee No.2 was unsure of how to answer the question, however she feels the main issue is with the aftercare, because even if they have more beds and staff available, they still need to have the aftercare available for after the operations.

Question 10: *Would you be willing to be contacted again to help provide further feedback, as this project progresses?*

Both interviewees were very happy to be contacted again for the study.

Feedback and recommendations from the Interviews:
1. The homecare helpers are under deep pressures in their line of work

Recommendation: The app must be quick and easy to use for the Social Workers/GP, to help relieve the pressures of their workload.

2. Help is not readily available for all who are discharged from hospitals

Recommendation: Ensure there are features in place that will accommodate for those not receiving the care they are entitled to.

3. NHS Departments are not well integrated and communication is poor

Recommendation: Each user profile could be integrated for all the departments for the NHS, for all users to see the necessary information needed for them to do their job function.

4. Social workers/District nurses regularly run late, and do not make the patients aware of this

Recommendation: A feature that allows the social workers to alert the elderly patient if they are running late, and what there estimated time of arrival will be.

5. A button that can be pressed to alert someone to come and help would be preferable, if it was not expensive

Recommendation: A feature that allows the user to dial 111 or 999 at the click of a button. Also, an emergency call button to ring family members.

6. User group had never used any kind of technology to monitor their medical needs

Recommendation: Extensive training, and an easy to use User Interface is a critical feature.

3.3 Questionnaires

The Pilot

Before releasing the questionnaire to a large group of respondents, ensuring the questionnaire made sense was imperative. The questionnaire needs to ask the most relevant questions specific to the project. Therefore, it was decided to create a pilot questionnaire to test on a medical student at Cardiff University. This way a response can be gathered by someone in the medical field, who would know about these issues better than the author.

From the student's responses, it was noticeable that some of the wording in the questions was rather lengthy, therefore she was providing some answers such as 'maybe' and 'Don't know', which showed that the question may be quite vague as to what it is asking.

For example, this was the original question for Question 5 was:

"In England over the past four years, the number of older people getting help with social care has fallen by a quarter. In your line of work, have you ever experienced elderly people who have struggled to access medication on time, due to such high demands for social care?"

This is a very long question, and the respondent may forget what the beginning of the question was asking when they get to the end. Due to wanting many responses on the questionnaire, it was thought this question would put people off from responding, as

it takes too long to answer the question. Therefore, from this, it was decided to shorten the question, and make it easier to understand. Here is the revised question:

"Have you ever been in a situation where an elderly person you know has been well enough to be discharged from hospital, but could not do so due to lack of care when at home?"

This question gets to the point, is nearly half as short and is easier to understand.

The section that needs the most explanation is the technology section. This is since it is a new concept being brought up, and as the respondent is a medical student, it is unknown how much technical knowledge she has. In the pilot, a question was asked which was looking to see whether the medical professional thought that elderly patients would benefit from a system that would send their medical information to their GP/Social worker. However, at the point of setting the question, it was not realised that the question was too vague. When the pilot responder answered, she responded with 'Maybe', which implies the question was confusing.

The pilot question was:

"Do you think that elderly people would benefit from a home-care technology that would allow them to send medical information to their GP/Social Worker?"

As you can see, the question does not specify what type of information or technology that is meant from the question. Therefore, the revised question involved a scenario in the description of the question. This way, the respondent can adapt their answer based on the given scenario.

Below is the scenario and question provided:

"Consider an application which allows a patient who has just been discharged from hospital after having an operation. The app would allow the patient to send their Blood Pressure/Heart Rate to their GP/Social Worker/Carer (dependent on the individual) regularly."

"Based on the above scenario, do you think the discharged patient would benefit from an application such as this?"

As you can see, this question is a lot more self-explanatory, and reveals what the application would allow the patient to be able to do.

Based on this, it was decided that all the questions in this section should have a scenario, to ensure the respondent understood why the question was being asked.

The only comment that the pilot respondent added was "I'm confused with the mobility question why you want to track their mobility. Is it in case they fall? Or if they wander at night?" Due to this, the scenario to describe why this feature could be necessary was added, and the options for the respondent to select were limited.

After making the changes to the questionnaire, and adding in some small edits and grammar changes, it was decided that the questionnaire was ready for more responses, to gather a wider range of results.

The Questionnaire
Please see attached PDF of the Medical Questionnaire

To gather responses, several different methods were used. The target audience is very specific, so the questionnaire could not be made public to all, in case people tried to answer it without any medical experience, which could create biased and fake results. Therefore, the first people asked were medical students at Cardiff University. They were asked over social media, and asked to mention it to other students that they knew within the medical school. It was also mentioned to family and friends, if they knew of anyone who would be happy to fill in the questionnaire. This surprisingly gave several responses, which were not bias, as they did not know who the creator of the questionnaire was. It was decided to get the word across via social media. A description and link to the questionnaire on the Cardiff MedSoc was posted, which is Cardiff University's Medical Students official Facebook page. This would allow to gather more results from students in the medical school of all different disciplines. A social media forum called The Student Room[1] was used too, where a discussion was started on the forum. This allowed for easy targeting of medical students and graduates, and is a great place to gather opinions from anonymous users and those from any location in the UK.

Attempts to post the link to the questionnaire on The Student Doctor Network[2] were applied, however due to the terms and conditions for the forum, they did not allow for any surveys or questionnaires to be posted unless they were IRB Approved Research Surveys.

Based on the wide range of users targeted, the results will not be biased and will contain accurate information and opinions from genuine medical professionals. The users were provided with a week to respond to the questionnaire, and the availability to users to change their answers after they have submitted was available.

3.4 Questionnaire Analysis

Section 1: Demographics
In this section, graphical representations of the questionnaire responses will be presented. It will show trends between the profession and age of the respondents, to see if this changes their views on the idea. All questions asked are non-identifiable.

Question 1

What is your occupation?

This question was asked to see how the respondent's current occupation is related to the medical field. This will allow for comparison of the individuals results against age and opinion on the app, to see if there is any correlation between their answers.

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[1] https://www.thestudentroom.co.uk/
[2] https://www.studentdoctor.net/
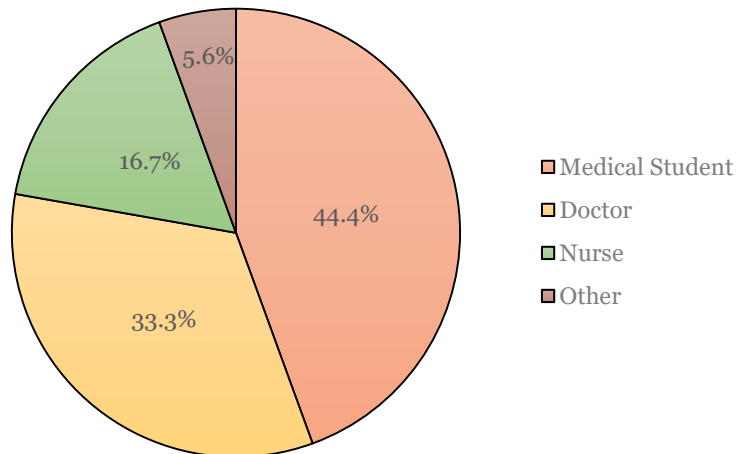
What is your occupation?

Figure 2: What is your occupation?

As you can see from the results gathered, a wide range of answers from doctors, nurses and medical students have been received. This ensures that the responses are not biased towards one type of user, and helps to gain a perspective from each occupational group. The one respondent in 'Other', is a retired nurse and Carer.

Question 2

Which age group do you fall into?

This question was asked to see if the age of the respondent relates to their opinion on the application. A multiple-choice response was set up for the respondents to select the option they fit in to.

Which age group do you fall into?
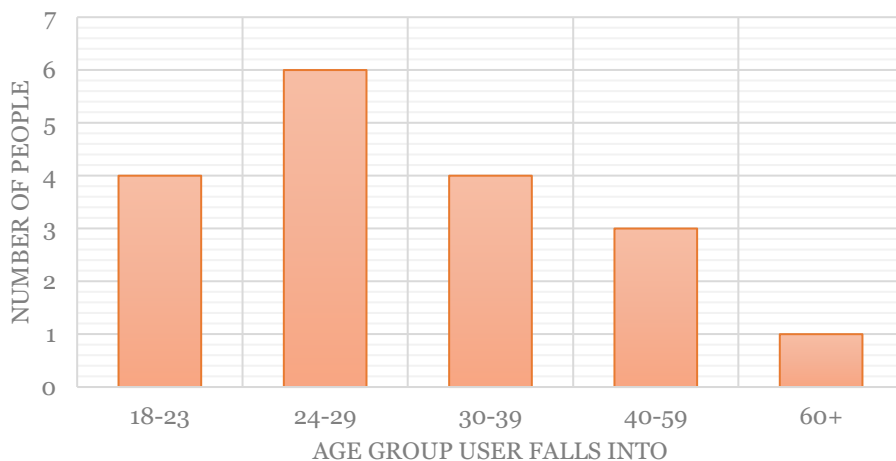
Figure 3: Age group of users

As you can see from the results above, a wide range of responses has been gathered from people of different age groups. This congregates an extensive range of opinions on the application, rather than just one age groups opinion.

Question 3

How are you related to the medical field?

Although this question is similar to question 1, it allows the respondent to be more specific with their answer. Therefore, if the respondent specialises in a particular area of medicine, they can add it in here. It is easy to see more specifically, the types of users who are responding to the questions.
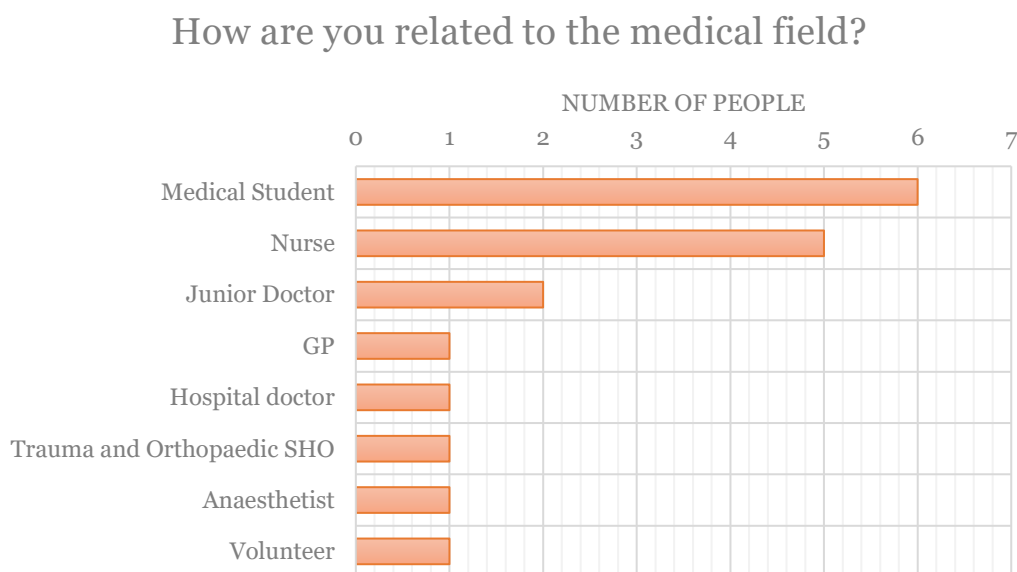
Figure 4: How the respondents relate to the medical field

As you can see, 35% of the responses are from medical students. The rest are from nurses, GP's, specialist medical professionals, and one hospital volunteer.

Question 4

How many years' experience have you had working in the medical field?

This question was asked to see how much experience the respondents have in the medical field. This question will be important to see the correlation between respondent's age and experience, as well as their opinions on whether they think the application will be useful.

How many years experience have you had working in the medical field?
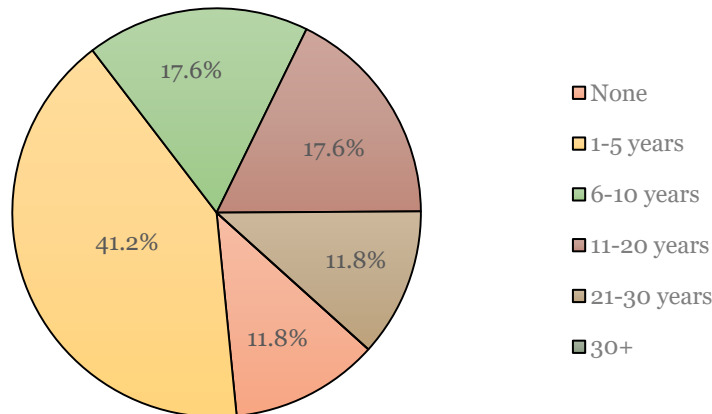
Figure 5: Respondents experience within the medical field

As you can see responses have been received from at least one person in almost every age group. This allows for representation of a wide range of responses from people in the medical field, all with a different amount of experience, which will allow for gathering a valid un-biased range of results. The experience of the user will be used to see if there is any relationship between their experience, and their opinion on the idea of the application.

Section 2: Medical Experience

In this section, an understanding about the respondent's experiences in the NHS is required. This section will gather the respondent's opinions about the way the NHS operates, and if there is any room for improvement. The questions will be steered towards the elderly patients, and will provide room for the respondents to add in comments from their own experiences where necessary.

Question 5

Have you ever been in a situation where an elderly person you know has been well enough to be discharged from hospital, but could not do so due to lack of care when at home?

This question has been asked to see whether the secondary research undertaken, is a reflected and shared opinion from people who have first-hand experience of working within the NHS. This question allows the respondents to answer based on personal experiences, or experiences they have had throughout their professional career.

Have you ever been in a situation where an elderly person you know has been well enough to be discharged from hospital, but could not do so due to lack of care when at home?

83.3%

11.1%

5.6%

Yes

No

Other
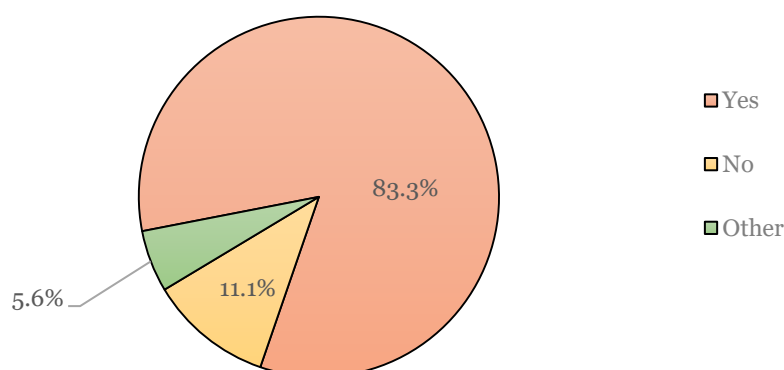
Figure 6: Elderly people being discharged before care is available at home

As you can see from the above response, the clear majority of responses say 'Yes', which proves that there is an issue with the support available for elderly people when they return home from hospital.

Question 6

Hospital records suggest nearly three-quarters of NHS trusts had seen patients stranded for more than 100 days in the past three years. Do you feel this can lead to further complications if elderly people are left in the hospital for longer than is necessary?

This question was asked to see if the respondents believe that this is an issue that needs to be dealt with differently than the current methodologies used in the NHS. Through preliminary research with elderly patients, it was found that an elderly person's health conditions can cause them to deteriorate and become isolated if left in the hospital longer than necessary. The answers from this question should help to gain the viewpoint of a medical professional, to see if it differs to the elderly patient's opinions.

Hospital records suggest nearly three-quarters of NHS
trusts had seen patients stranded for more than 100
days in the past three years. Do you feel this can lead to
further complications if elderly people are left in the
hospital for longer than is necess
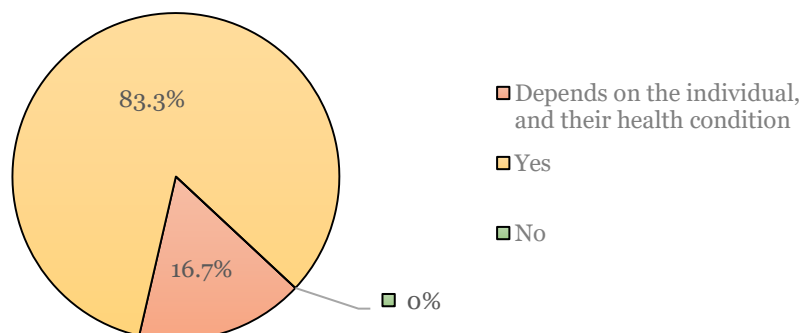
Figure 7: Complications if elderly patients in hospital longer than necessary

This question shows that the clear majority of respondents said they believed a patient staying in hospital longer than necessary can cause further health complications. This question implies that these respondents believe that patients should be discharged from hospital as soon as they are healthy enough to do so, and have the sufficient care at home available to them.

Question 7

From your experience, how would you rate the communication between the hospital and the social care?

For this question, the respondents were given a choice of options, from 'Extremely Poor' all the way up to 'Great', regarding how good the communication between the hospital and social care can be. This question was asked to see if there is a good method in place currently to enforce communication, or if there is room for improvement in this area. For the application, great communication between the hospital and social care will need to be in place, so this question was asked to see if this will need to be considered when designing the features of the application.

From your experience, how would you rate the communication between the hospital and the social care?
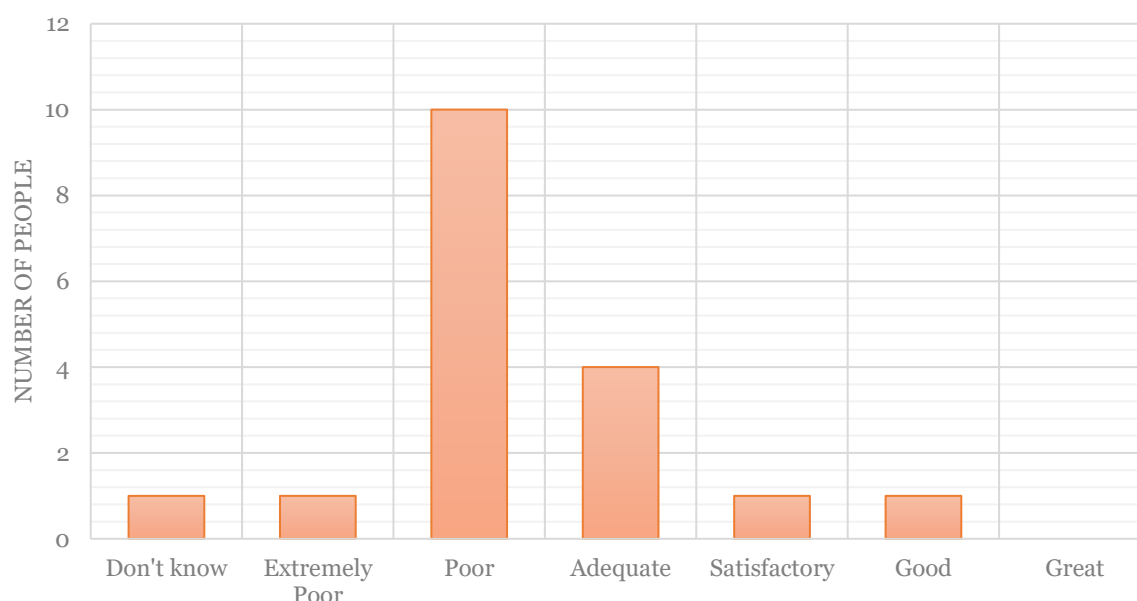
Figure 8: Communication between hospital and social care

As you can see from the results, over half of the respondents answered 'Poor' to the communication methods. Only 2 respondents said the communication was 'Satisfactory' and 'Good', which is a very small percentage, compared to those who said it was adequate, poor and extremely poor. This shows that there is room for improvement in this area, and could be why elderly patients are struggling to leave hospital on time. The following question explains why the respondents chose these answers.

Question 8

Based on your previous answer to Question 7, please explain why you selected this option.

This is an optional open-ended question to understand why the respondents chose the option they did in the previous question, and to understand the relationship between the hospital and social care further, to see why they believe this is happening.

Below are some of the answers:

Respondent answered 'Poor': "When volunteering at a care home, we had several occasions where there was a clear breakdown in communication between the hospital."

Respondent answered 'Good': "Communication is good, but doesn't change the fact that the care that is needed is frequently just not available."

Respondent answered "Poor": "Social care is underfunded understaffed, with an impression of too high a workload for current staff".

Respondent answered "Adequate": "Can be very poor. But often good communication between teams but it still takes a long time for patients needs to be met".

Respondent answered "Adequate": "Social care is slow and it's very difficult to try to discharge anyone home outside of 9-5 Monday to Thursday. The communication itself is probably adequate though".

Respondent answered: "Poor": "Shortage of nursing staff and social workers result in lack of communication and agreement between patient, nurse, doctor, social workers, physio, occupational therapists, and family. Repeated outdated paperwork. Poor social care resources. Need better referral service and better system for service implementation".

The comments have been broken down into more specific bullet points, from the general consensus:

- Breakdown of communication between the hospital
- Arranging Social Care
- Care is not frequently available
- Difficult to contact social care
- Underfunding and understaffed social care and nurses
- Speed of social care
- Delayed discharge
- Limited support

From the results, you can see that the respondents tend to steer towards blaming the social care. Several saying there is poor communication and resources available, and that they are under-staffed and underfunded. As a majority response, it shows that the areas of improvement mainly are within social care funding, response and resources.

Question 9

What do you feel puts the most pressure on the NHS to deliver the service it provides? If 'Other', please explain your answer. Please select all that apply.
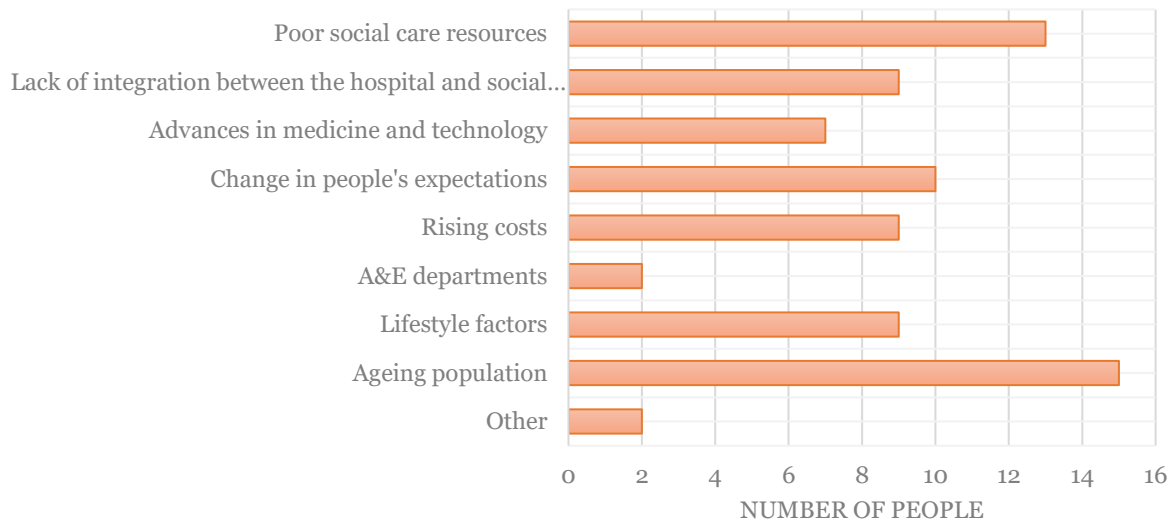
This question was chosen to see what the respondents think is the reason the NHS is currently struggling to cope with its strain on resources. This question is relevant to the project, to see which areas of the project to focus on further, to try and improve these services. The respondents were given a choice of checkboxes, so they can select more than one answer if they feel that is necessary. The 'Other' option is provided so the respondents can add in their own opinion, if they feel it has not already been provided as an option.

Figure 9: Pressure on the NHS

As you can see the result the highest number of people selected is 'Ageing population'. 15 out of the 18 respondents believed this is what is putting the most pressure on the NHS currently. This is not something that can be dealt with easily, however it proves that there is room for improvement into the resources available for the elderly people to stay safe in their own homes, and to allow them to monitor their own medical needs (if appropriate). The second highest response is 'Poor social care resources'. This relates back to Question 8, in which several of the respondents explain why they believe there is poor social care resources, and that these need significant improvement. The 'Other' option provided from one respondent suggested: "*People not being able to get a GP appointment so going to ED* (Emergency Department) *instead, lack of knowledge and education of when to go to ED*". The respondent makes a good point, and this is possibly why very few respondents chose 'A&E departments' as their option, as they do not feel it is the A&E departments fault that they are outrageously busy with patient's issues that could easily be dealt with by the GP.

Section 3: Technology

The questions in this section are looking to see what the medical professional's opinion would be on mobile applications used to monitor elderly patients who have recently been discharged from hospital. It will allow for gathering of requirements and opinions from the people who know what is needed to care for these patients. This section will help to determine where to focus within the project, and to see what the respondents feel would be the most useful features for an application like the one described.

Question 10

"*Consider an application which allows a patient who has just been discharged from hospital after having an operation. The app would allow the patient to send their*

Blood Pressure/Heart Rate to their GP/Social Worker/Carer (dependent on the individual) regularly."

Based on the above scenario, do you think the discharged patient would benefit from an application such as this? If 'Other', please elaborate."

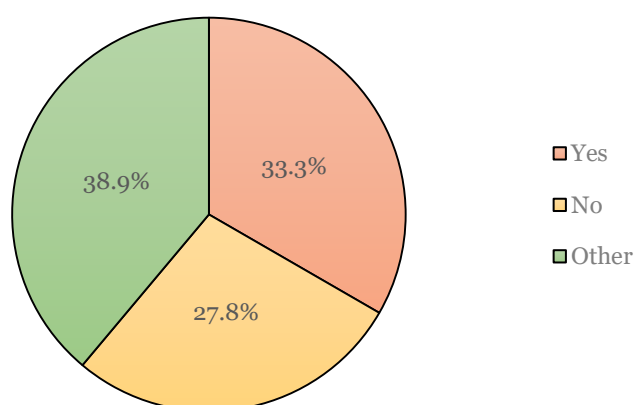This question has been asked to help determine whether the medical professionals think an app like this would be useful and relevant for the situation described.

Based on the above scenario, do you think the discharged patient would benefit from an application such as this? If 'Other', please elaborate.

Figure 10: Would patients benefit from this type of application

Based on the response, there is a mixture of opinions. 3 out of 5 that answered 'Yes' are medical students. Those that answered 'No', 3 out of 5 of these are Doctors. There were several comments made on the 'Other' section, with the respondents who are apprehensive about the app, but believe it has potential. Below are a few of the comments made in the 'Other' section:

"Some may, but many elderly patients, particularly those with dementia, are not able to use smartphones"

"That's fine but these observations are not necessarily what is required, have to disagree with the GP as recipient - I don't have time to manage transition to out of hospital care by providing constant observations of health parameters."

"All this does is generate anxiety. Blood pressure and heart rate aren't really the significant concerns after someone is sent home. Long term monitoring of blood pressure and diabetes - it would be useful there though."

"It depends on the patient's age, capability of using technology and the patient's diagnosis"

"Beneficial only if patient or Carer able to carry out assessments"

"Potentially if the patient is given the right training to use the resource. We have to be sure that patients would be able to safely report any problems if they came up"

"Yes, provided they were able to record BP and use the app proficiently"

The general comments raise the issues that it completely depends on the individual's health concerns, as to whether they would be able to use the app themselves. A few of

the comments mention that they feel the Carer would also need to know how to use the application, and both the patient and Carers are able to carry out the assessments with the appropriate resources available, with a safe reporting system in place if there are any issues.

Question 11

Consider an application which allows a patient who has just been discharged from hospital after having an operation. The app would allow the patient to send their Blood Pressure/Heart Rate to their GP/Social Worker/Carer (dependent on the individual) regularly.

Have you ever used a similar app to the one described above?

This question has been asked to see if medical professionals have had experience using an application like the one the project describes. This information is useful to know whether this concept is already used within medicine or not. There are many apps and technologies around that measure blood pressure and other vitals, so it would be beneficial to know whether any of these apps are regularly used.
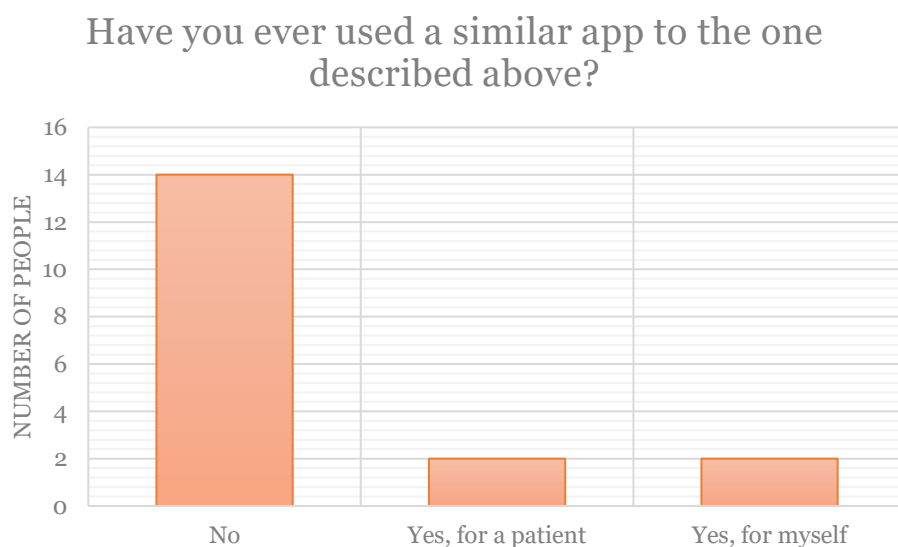
Figure 11: Would this app be of use to elderly patients?

As you can see, over ¾ of the respondents have never used an application like this before. From this, it can be seen that there is a gap in the market for this type of application. There is clearly not a current app/technology that is widely used to look after patient's needs.

Question 12

Consider a patient who has recently been discharged from hospital after an operation, and has been ordered by their GP that they must be relatively active throughout the day. If the patient kept still too long, their health would deteriorate. This would also benefit patient's whose awareness is poor. The patient has an app that sends regular updates to their GP/Social Worker if they are not completing their daily tasks.

Based on the above scenario, what do you think would be the most important features for this application? Please select all that apply. If 'Other', please suggest your opinion.

This question was asked to see what the respondents thought about the mobility tracking feature in the application. This is one of the areas that will be focussed on, to check that the patient has managed to get out of bed, or if they have been in their chair for a significant amount of time. The respondents were given a choice of 5 options, in which they could select all they felt would be necessary for the app. There was also the 'Other' option for the respondents to add in comments, about features they feel are not provided already.

Based on the above scenario, what do you think would be the most important features for this application? Please select all that apply. If 'Other', please suggest your opinion.
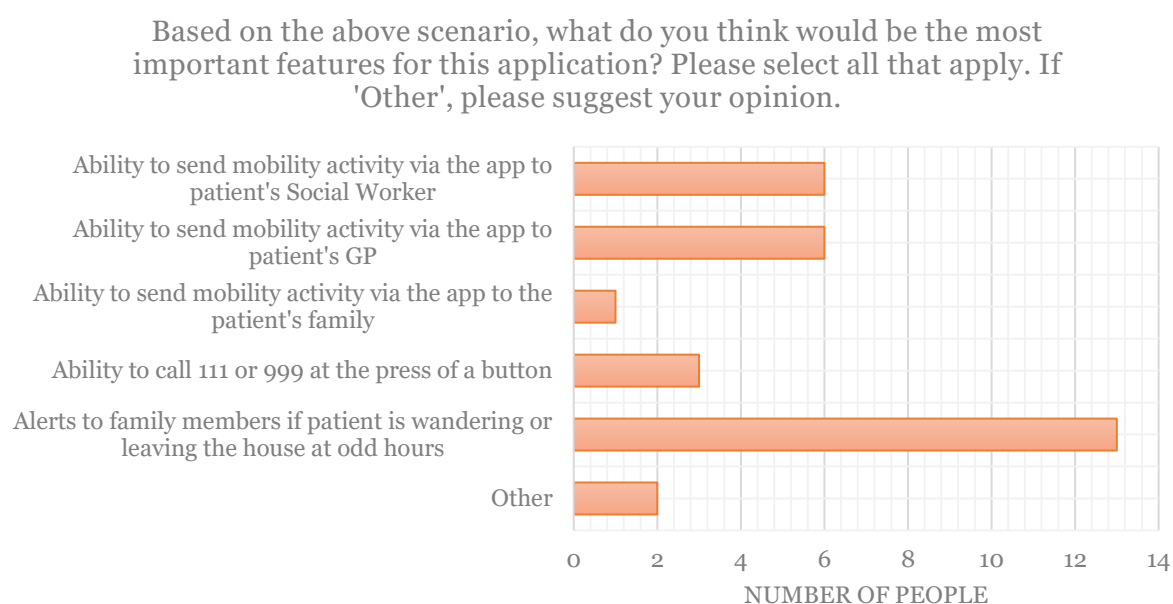
Figure 12: Features of the app applicable for mobility tracking

As you can see from the results, 13 out of 18 respondents thought that the best feature would be an alert to family members if the patient is wandering around the house or leaving it at odd hours during the day. Although this is the most highly rated feature, the feature with only one selection, is the ability to send mobility activity via the app to the patient's family. It seems they do not think the family would need to know if they are just getting up out of bed in the morning, but would need to intervene when the patient could potentially get themselves into trouble. It seems the respondents who think that activity should be sent anywhere, is to the social worker or the GP.

Question 13

Consider a patient who has been ordered to monitor their blood pressure every day for a month after being discharged from the hospital. The patient has an application that would allow them to take their blood pressure (and other vitals) without the need for a Carer to take their readings.

What do you think would be the most important features for a mobile application that would monitor the patient's vitals? If 'Other', please suggest your opinion.

This question was asked to see if the respondents felt that monitoring the patient's vitals would be a necessary after-care procedure for the elderly patients. There are several apps and technologies around that already fulfil this, however based on the results for Question 11, it is clear that these types of technologies are not currently in use.
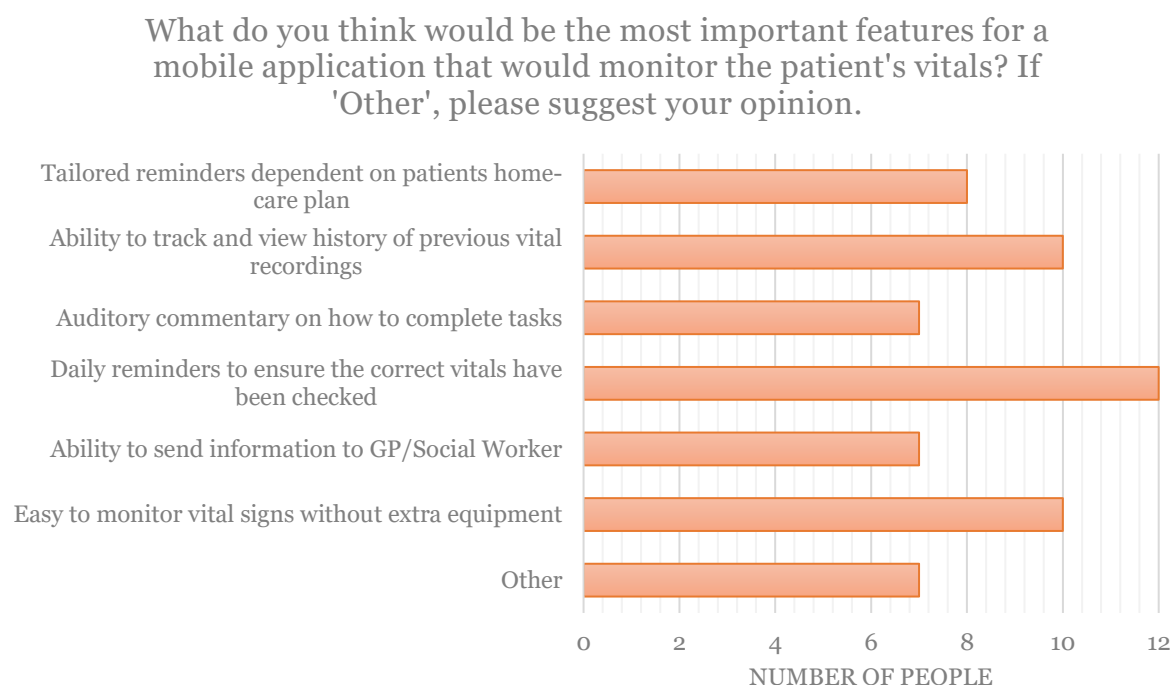
What do you think would be the most important features for a mobile application that would monitor the patient's vitals? If 'Other', please suggest your opinion.

Figure 13: Features of the app applicable to vital sign tracking

Based upon the above results, the most important feature that the respondents feel would be good for the app is the daily reminders to take vitals measurements. 12 out of 18 respondents also thought it would be necessary to be able to view the history of the previous vital recordings. This would allow the patients to see if there are any anomalies in their readings, or if there has been a sudden increase or decrease, in which this would encourage them to get in touch with their GP or Carer, depending on the issue. There were a few comments made in the 'Other' box from some of the respondents, several of them not understanding why this would be a necessary feature straight after coming out of hospital. Some examples of suggestions are:

"The sort of data that this would generate, daily BP for a month, is not useful data. Ambulatory BP is already employed in an evidence-based manner for diagnosis and management of hypertension. See NICE guidance."

"I don't know why a patient would need to monitor their blood pressure every day for a month after being discharged from hospital"

There were also some respondents that did not feel this would be a useful feature within the app, so did not choose any of the options. These are the comments made:

"I don't think this would be useful"

"I don't think this is a good idea. And social workers don't do vitals."

"I've never seen a patient like this. Post-op care at home is about help with daily tasks and wound dressings mainly, as well as someone to just check the patient feels ok.

Also, how are you going to measure blood pressure with no extra equipment? Surely impossible?"

All the comments received are useful towards the study, as understanding that this feature may not always be necessary will help to determine the correct features to include in the designs.

Question 14

Consider a patient who has several medications to take throughout the day, and needs to monitor their intake, and the times they take their medication.

What do you think would be the most important features for a mobile application that would remind patients to take their medicine? If 'Other', please suggest your opinion.

This question has been asked to gather options about the third requirement for the app - medical reminders. It was asked to see if medical professionals think this would be a useful feature for the application, and if so, what features it should entail. Respondents are encouraged to use the 'Other' box if they think there are any other features that could be of use.

What do you think would be the most important features for a mobile application that would remind patient's to take their medicine? If 'Other', please suggest your opinion.
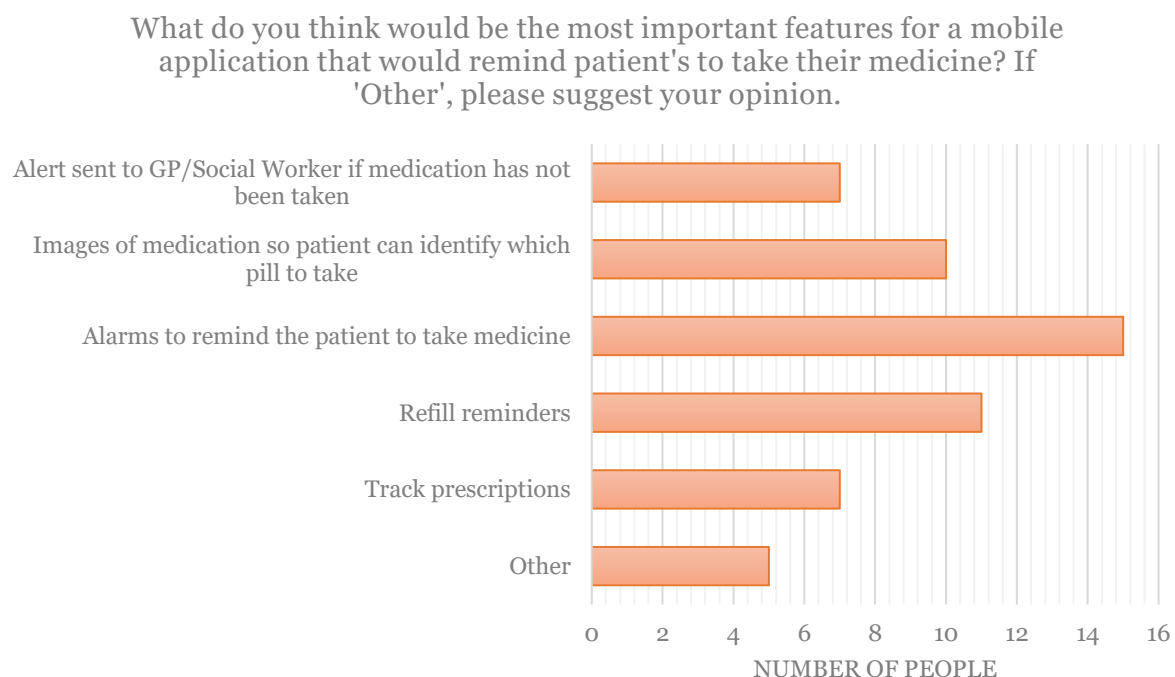
Figure 14: Features of the app that would be applicable for medical reminders

As you can see, 15 out of 18 respondents have said that an alarm to remind the patients to take their medicine is a very important feature for the app. The consensus implies that images of the medicines and refill reminders would be very useful too. In fact, for one of the 'Other' responses, the respondent who is a Junior Doctor replied, "Good Idea", which implies they think this would be a worthy feature to have implemented in the application. One suggestion was "Alerts to family/Carer would be better", which is not a feature originally thought of, and may be something to consider when designing the app.

Please answer this question using the information from the previous questions. The apps that would track mobility, vital signs and medication reminders for the recently discharged from hospital elderly patients.

What features of an application do you feel would be most appropriate for an app for the elderly? Please select all that apply.

This question is vital towards to the design and usability of the app. It was asked to help gather a non-technical minded response as to what would be a good usability and functions, specifically for the elderly patients. In the questionnaire, 12 options were provided to choose from, and the respondent could choose as many as they felt necessary for the app. The 'Other' options allows the respondents to add in their own choices.

What features of an application do you feel would be most appropriate
for an app for the elderly? Please select all that apply.
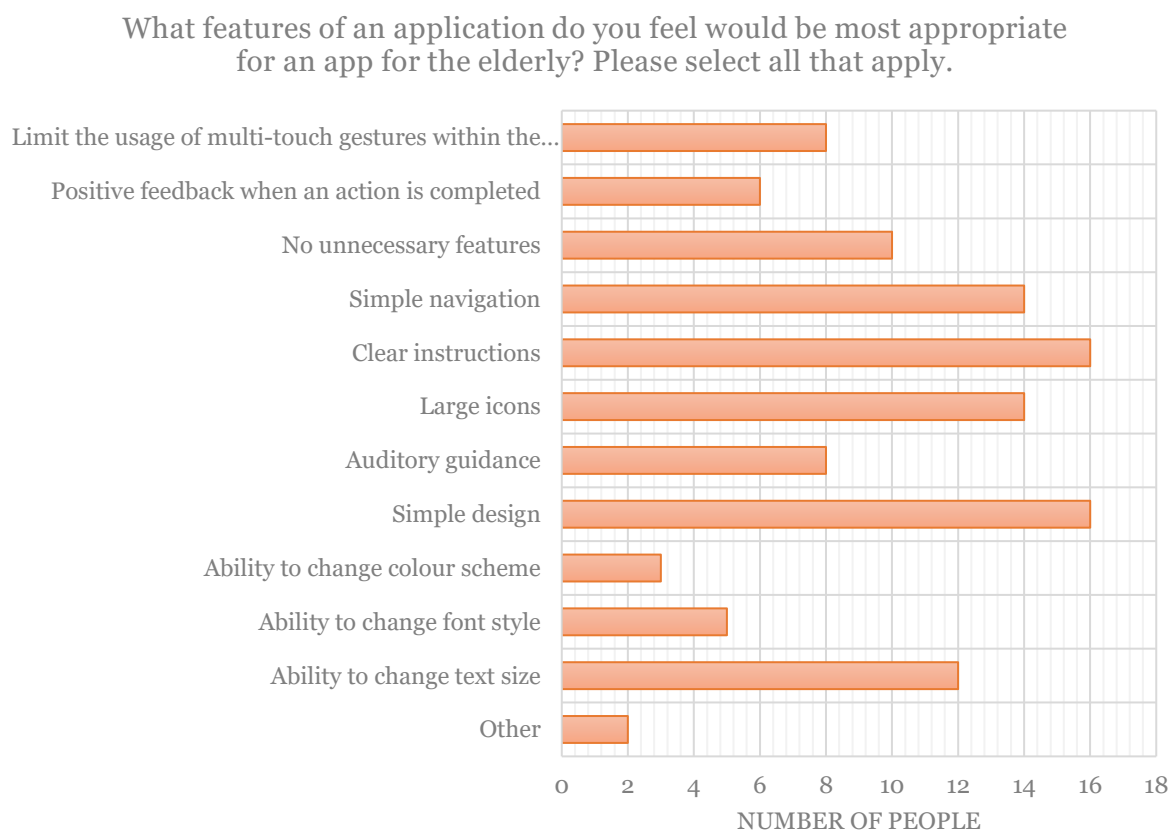
Figure 15: Features of the application appropriate for the elderly user

The response to this question was helpful – with many respondents selecting more than one choice. The most selected options are for clear instructions and a simple design. Also, 14 out of 18 respondents thought that simple navigation and large icons would be key features too. Overall the response was well received, apart from one user, a hospital doctor, who responded in 'Other' with "I really don't think a frail elderly person discharged from hospital would use this sort of app. Very few elderly people have smartphones."

What features would you, (as a medical professional) like to see on the app?

This question was asked to see whether medical professionals would also use the application. It would be necessary for there to be interaction and response between the medical professional and the patient. The medical professional would need to be on board with the application, even if the user interface is differing from the patients. The responses should help to gather similar opinions on the types of features medical professionals would like to see from their end user view. The idea of these features is to help relieve strain on the NHS, by giving the medical professional more time to fulfil their daily tasks as necessary.
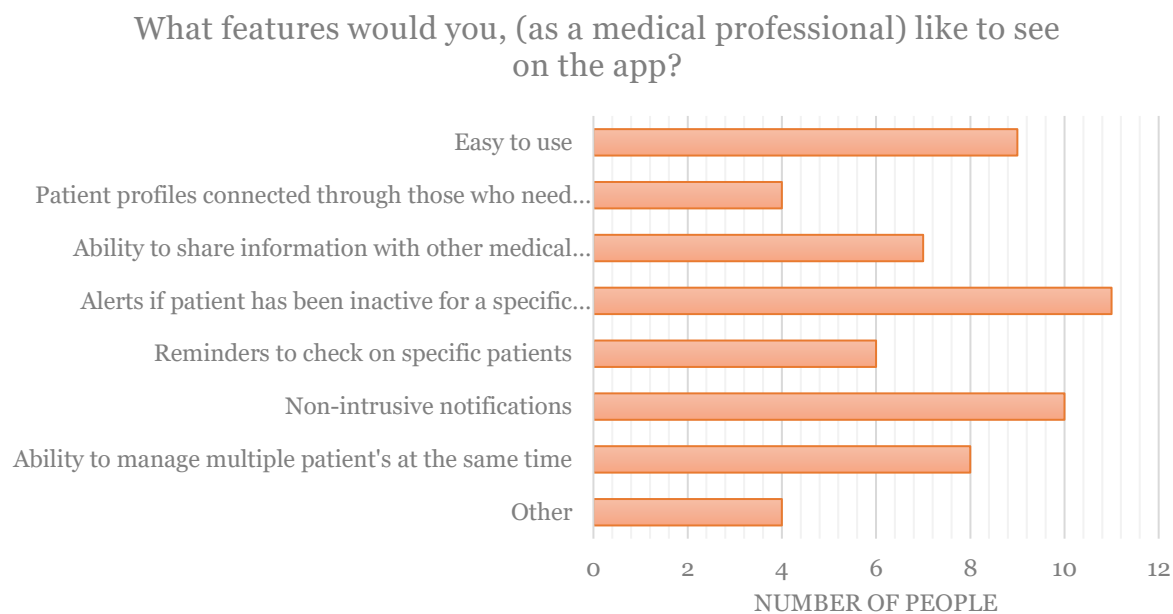
Figure 16: Features of the application for the medical professional

From the responses, 10 out of 18 users thought that it would be useful to have alerts received if the patient has been inactive for a specific amount of time. It is surprising that 11 out 18 chose this option, because in Question 12 when one of the options for a mobility tracker was "Ability to send mobility activity via the app to the Social Worker/GP", only 6 out of 18 respondents chose these options. Another very important feature that most respondents who like the idea of the app chose, 'Non-intrusive notifications' and 'easy to use', which is understandable due to medical professionals needing to prioritise their time, and not wanting to waste their time on an app that would take a long time to input information.

Optional Section

At the end of the questionnaire, there was an optional section that would allow users who are interested in the study, to sign up to potentially be required for further feedback/user testing. Users were asked to provide their email address and their preference of mobile operating system (OS).

This information will be useful as the project progresses, as users will be required to provide feedback when the prototype design is created, based on all the gathered

research. Preference of Mobile OS was asked in case medical professional users are needed for the user testing stage.

These questions were optional, so users who wanted to stay anonymous, could still submit the questionnaire.

The final question was an optional question about what could be done to improve the questionnaire. This section was provided to help understand what could have done better, and to receive any further comments that may be necessary for the application.

One respondent replied with "Honestly - there are lots of odd questions that show you're not really that familiar with the things you're talking about. Firstly, you only have two 'doctor' options when asking what sort of professional I am - what about everyone else who is neither a GP nor a surgeon? Consultant physicians? I'm not sure why you think that A&E should be one of the things in the list that 'puts pressure on the NHS' - A&E IS the NHS, and the problem is the pressure that is put on A&E, not the pressure that A&E puts elsewhere. Social workers do not take vital signs, as you have suggested. Doctors just do not have the time to care about the minute details you have suggested such as whether a patient has used the app or what their BP is every day. The types of people (frail, elderly) whom you're alluding to as the sorts of people whose discharge might be facilitated by suing this app, are highly unlikely to have smartphones or be able to use such an app."

This respondent has provided a lot of good points that were not realised when creating the questionnaire. Although the respondent does not think the app would be useful, they have provided a lot of information that would not have been previously known.

Other respondents commented, "I take it you are aware of Withings!!!" and "Send it to family members of elderly people. Also, some HCP already use such apps". It was not mentioned in the questionnaire that preliminary research had already been undertaken, and these applications had already been looked into, therefore it is understandable why they thought to comment about these types of apps/technological devices.

One respondent provided some extra comments about how the project could be considered. They said "The idea is quite nice but I think you need to consider a) how many elderly people would use an app (why not target the app at a younger population?), and b) what the app would realistically be used for - some of the examples given in this questionnaire are quite unrealistic as I think you are aware of. You perhaps need to do some research with medical/social professionals into what would be useful." This response is very useful, and will help when considering the functionalities and appropriateness of the application.

Reflection on design and data collection
Overall, the questionnaire was responded to well, and the design was appropriate, however there was definitely room for improvements.

Design
The design for the questionnaire was suitable – the questions were specific to each section and after the changes from the pilot, it was easy to understand why the questions were asked. Using a mixture of both open and closed questions was a good way to split up the questionnaire, and allowed for a greater opinion and an easier analysis of results. Each section had a description, and started with an easy, closed

question to start off each section. It was decided to only have a couple open ended and optional questions, as it is known that people tend to skip questions that are not mandatory for a response. There were not too many ambiguously worded questions, and those that may gather opinions, there was an 'Other' option, so that the respondents could add in their opinions if they felt this would be necessary. This ensured that answer choices anticipated all possibilities. In the technical section, consideration that the users may not be technically minded was taken into attention, therefore it was ensured that any technical terms or jargon that may confuse the users were avoided.

For the multiple-choice questions in the Technology section, short and precise answers were provided, this way the user did not have to read all the choices extensively, and could quickly choose which options they felt would be appropriate for the app.

Data Collection

It was stated previously in the Questionnaire Planning section how the medical professionals were contacted to take the survey. This process could have gone smoother; however, it was very difficult to get in touch with medical professionals who have time to fill in a questionnaire. Therefore, a lot of the responses were from acquaintances or mutual friends. A few responses were received from the Facebook post on Cardiff MedSoc group, however the members of the group do not get notified when somebody posts, so the post would not have been seen unless a user clicked on the 'Visitor Posts' section. On reflection, it would have been very beneficial to get in touch with local GP's and other university's medical schools, however with only a short amount of time to fill in the questionnaire, this would be unnecessary considering the large response gathered from those that did answer the questionnaire.

At the end of the questionnaire, the respondents were asked to whether there is any room for improvement in the questionnaire, and a few comments were received. One respondent mentioned that it was obvious that the creator of the questionnaire did not have medical experience, due to some of the options available for users to select. On reflection, more research into the options would have been advantageous. However, this was the reason many of the questions in the first two sections were asked, to gather more insight into the medical field, and understand what is needed to look after the elderly once they have been discharged from hospital.

Questionnaire: Carers

It was decided to create a questionnaire that wasn't just specific for medical professionals, therefore a specific questionnaire aimed at Carers was sent out to known Carers who have experience with elderly patients. The questionnaire did not differ too much to the medical questionnaire, however the questions were worded slightly differently, and a few more specific questions were asked about the communication between medical professionals and Carers. Due to the specificity of this questionnaire, only 4 responses were received, therefore a full analysis will not be completed from this, as the sample space is not large enough, and the results will not be precise enough to form a valid response from.

The results regarding application features and currently available applications were of a very similar response to the medical questionnaire, with all respondents saying they had never used an app like the one described in the questionnaire. 75% of the

respondents also added that they thought an app such as this, would be beneficial for the patient.

With the more specific Carer questions, all respondents described the communication between the Carer and the GP, ranging from Adequate to Extremely poor. Therefore, it is clear from the small number of results, that the connections between medical professionals and social Carer professionals is relatively poor.

Please see Carers Edition- The Usability of Mobile Devices for Elderly patients (Responses), for a full overview of responses.

3.5 Analysis of Existing Applications

To understand the functionality and usability of medical applications, an analysis is to be done on current applications that are already available to download on mobile devices. Based on discoveries in Chapter 1.2 Current homecare technologies, there are not any appropriate applications to compare accurately when it comes to mobility tracking and vital signs. Therefore, a comparison and gap analysis based on two medical reminder applications will be undertaken. The two applications that have been chosen for comparison and analysis are Med Helper [11] and Medisafe [12]. These are both free applications available on Android and iOS devices.

State Transition Networks
State Transition Networks (STN) have been created for all the tasks that are relevant to the applications. There is a STN for both Medisafe and Med Helper, to help see the comparison between them both. The diagrams show the flow between of the stages within the application, to help reach the destination of the given task. An example of the state transition diagrams is given below. The rest of the diagrams can be seen in the appendix.

Task: Add a new medicine/prescription

Med Helper

<u>Medisafe</u>

State #1: The displays the application main area

User presses the red plus in the bottom right hand corner of the application

State #2: The system displays a pop-up with a number of options

User selects 'Add Medication'

State #3: The system displays a new page with input forms for Medication Name

User leaves field blank

State #10: User cannot progress to add a medication without it having a name

User accepts authentication method

User enters medication name and selects 'Next'

User starts to type in medicine and selects pre-set option

State #4: More input forms available for Reminder Times, Schedule and Shape & Colour

The user turns off reminders

State #11: The system removes the ability to add reminders and scheduling

User selects reminder timings and dose

State #5: The system displays the chosen options for Medication Name and Reminder Times

User selects 'Next'

User selects schedule

State #6: The system displays all selected information for medication name, reminder times and schedule.

User selects 'Next'

State #7: The system adds a new input form for Shape and Colour

User selects shape and colour for medicine

State #8: The system displays all the selected information for medication name, reminder times, schedule and shape and colour of pill.

User selects 'Done'

State #9: The system saves the information and adds the pill to the Pillbox

3.6 Heuristic Evaluation

A heuristic evaluation has been undertaken on the two medical reminder applications that have been chosen for comparison to gather requirements, and help to determine features that already have good usability, as well as those that currently have usability issues that could be changed. In an article written by Jakob Nielsen in April 1990, it mentions "heuristic evaluation is done by looking at an interface and trying to come up with an opinion about what is good and bad about the interface [13]." The two applications chosen for the heuristic evaluation are Med Helper Pill Reminder and Medisafe – these applications are not specific for elderly people to use; however, analysis will be done from a perspective that would be valuable and operational for an elderly user.

<u>Nielson's Heuristics</u>
Jakob Nielsen created the 10 Usability Heuristics for User Interface Design. These heuristics cover a wide range of principles that are general for interaction design. Nielsen's heuristics were chosen over the other options for analysing usability factors, because Nielsen has not just considered design for web applications, he has also

researched them for mobile usability. This will be a very useful technique for this project, as Nielsen recognises that mobile design is different to website design.

The 10 Usability Heuristics for User Interface Design are [14]:

1. Visibility of System Status
2. Match between System and the Real World
3. User Control and Freedom
4. Consistency and Standards
5. Error Prevention
6. Recognition rather than Recall
7. Flexibility and Efficiency of use
8. Aesthetic and Minimalist Design
9. Help User's Recognise, Diagnose, and Recover from Errors
10. Help and Documentation

Each of these heuristics help towards the design of user interfaces, and improve user experience when they are using the application/device at hand.

It is necessary when undertaking a heuristic evaluation to include severity ratings. This helps to determine the priorities of features during the design phase. The priorities are based on the impact the problem will have on the user's experience. However, these are often relied upon from the opinions of the evaluator.

Severity Rating Scale:

Below is the severity single rating scale that will be used for the heuristic evaluation [15]:

0. This is not a usability problem
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 before product can be released

Heuristic Evaluation Results

The heuristic evaluation has been undertaken on Med Helper Pill Reminder version 2.7.7 and Medisafe Meds & Pill Reminder v.7.21. This will be evaluated on a Samsung Galaxy S6 SM-G920F, Android Version: 6.0.1.

For the purpose of the report, only a sample of the heuristic evaluation has been included. The full heuristic evaluation can be found in the appendix.

Table 1 – Heuristic Evaluation 1

Problem Number:	1
Problem Title:	No instructions or tutorial when first time opening app
Severity Rating:	3
Heuristic violated:	Visibility of system status

	Flexibility and efficiency of use
	Help and documentation

Problem Description:	• When you open the app for the first time, it does not prompt the user to do anything • No instructions as to how to add medication reminders • The screen has no onscreen help or easy to find tutorial • Users must rely on knowledge about applications, to know how to use the app • There is an external link to a webpage which has options for 'Manual' and 'Tutorial', however this would take the user out of the app. It is not easy to know how to return to the app after this. • The links to the 'Manual' and 'Tutorial' are poorly designed, as the font colour does not contrast with the blue background. Therefore, you can barely read the content.
Recommendations:	• When the user enters the app for the first time, a video should be shown on how to use the application • A tutorial and hints should be shown when the user is using the app, and they can remove them easily once they have found what they want to do

Additional Information:
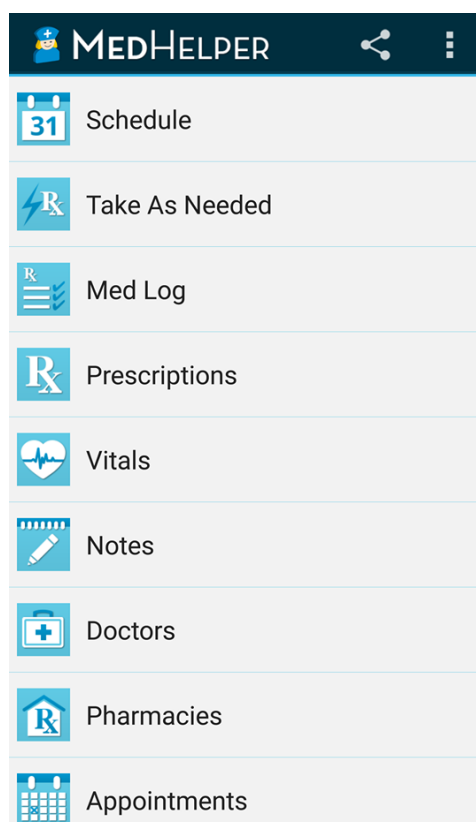
Figure 17: Med Helper Home Page

This is the screen that is presented when you open the app for the first time. This is the homepage for the app.

The button the user must press to access the list which will allow them to access tutorial on how to use the app

The list of options available once the link has been pressed. The poor visibility of links violates Nielsen's heuristic: Aesthetic and minimalist design
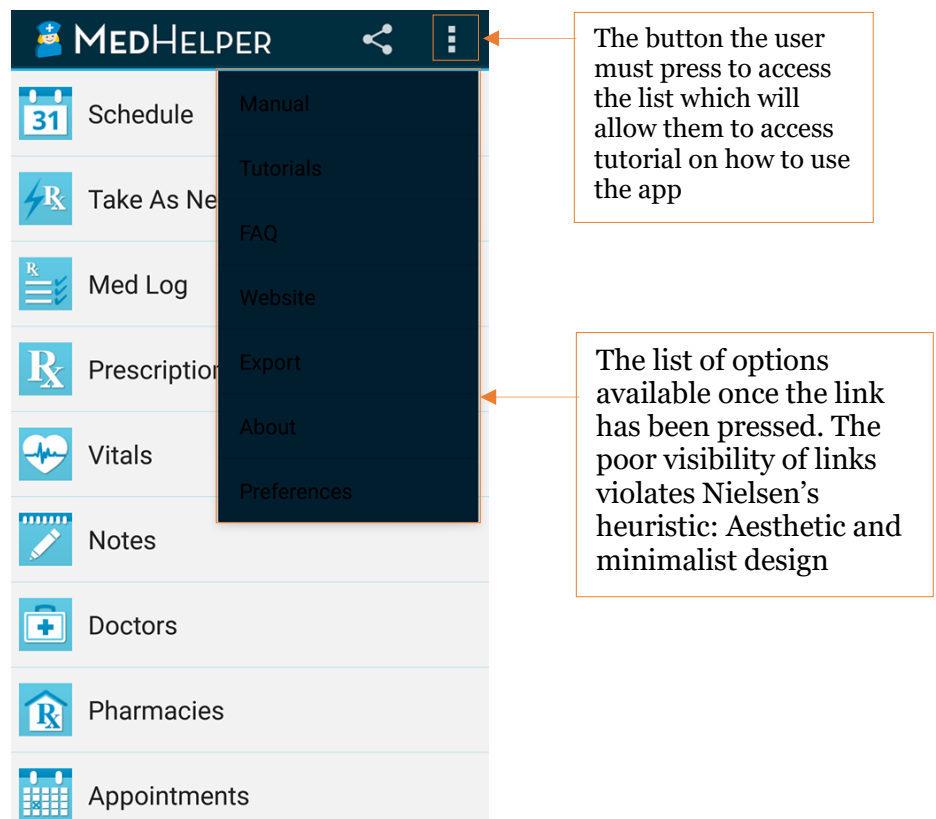
Figure 18: Med Helper Settings

To find a tutorial on how to use the app you must click on the three dots symbol in the top right hand corner. If you had not used any sort of application before, you would not know what this means. Also, as you can see, it brings up a drop-down list, but you cannot see what the links are due to the poor contrast of the navy-blue background and the black text. The colour scheme for this is very poor, and would not be appropriate for any user.
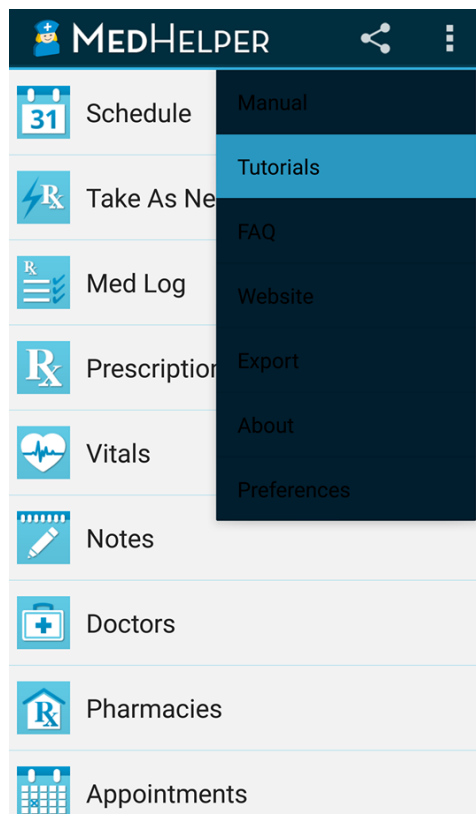
Figure 19: Med Helper tutorial

Here you can see that the 'Tutorial' link is highlighted. The only way you can see this is if you hold down the option. An elderly user would not know how to do this. This colour scheme is easier to read, and should be used instead of the blue and black they currently have in place. When you click on this link, users control and freedom is violated, as they do not get any message or alert to let them know that if they click this link they will be taken to an external webpage. The user does not get the choice to stay on the app. This is poor usability in terms of consistency, as the user is not made aware that some of the links are external and some are internal to the app.
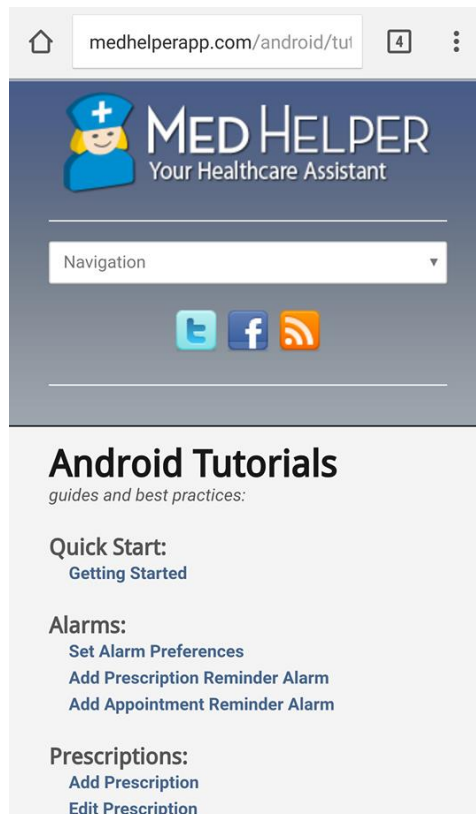
Figure 20: Med Helper Assistance

This is the external page the user is taken to if they click on the 'Tutorial' button. If the user reached this page, they may still struggle to understand how to access the information necessary, as there are lots of further links.

Table 14– Heuristic Evaluation 2	
Problem Number:	14
Problem Title:	Logging in to the application
Severity Rating:	1
Applicable Heuristics:	Help users recognize, diagnose, and recover from errors
Problem Description:	The application will let the user know when the password or username is incorrect. For example, in Figure 22 it states that the password must be at least 6 characters in length.
Recommendations:	When the user enters in the username and password incorrectly, the system could let the user know which field was entered incorrectly.

Additional Information:
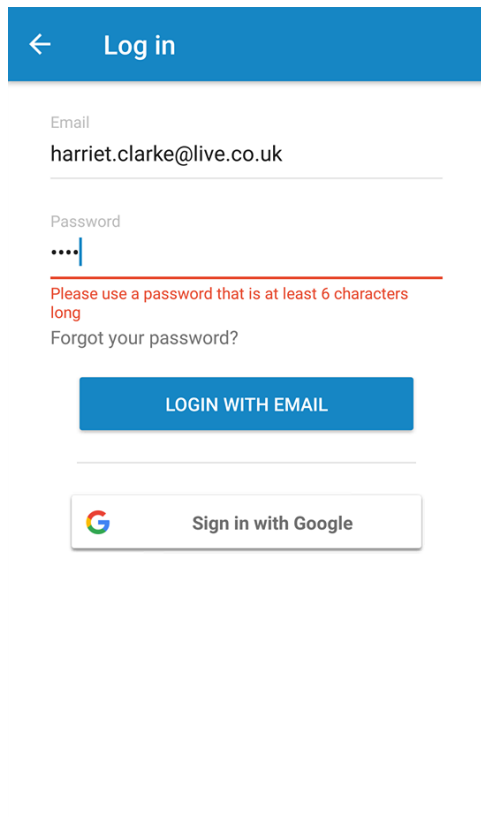
Figure 21: Logging in with incorrect password
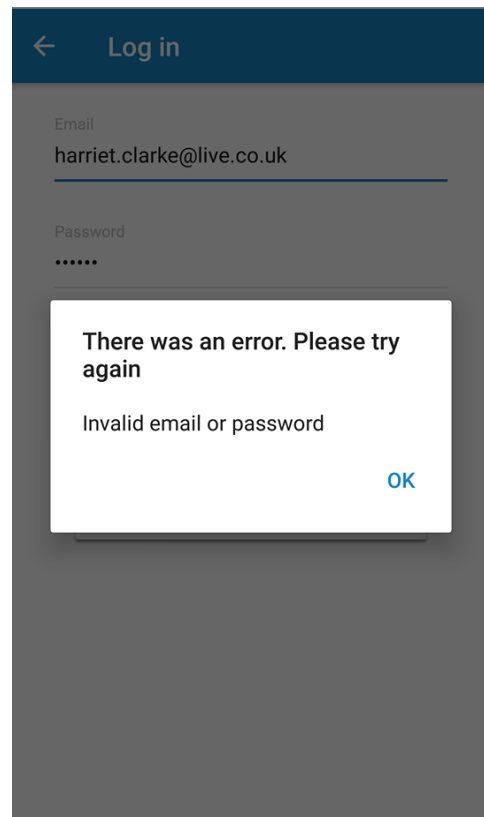
Figure 22: Error message presented

Current Applications: Elderly person perspective

An elderly person who was previously interviewed in the
Interviews section (Page 14), was asked to try to use Med Helper and Medisafe to see
if they were usable for an elderly user, and to see what they liked or disliked about the
applications. Here are the results:

Med Helper:

↳ User struggled to understand where the 'back' button was, and attempted to press
the button on the calendar which takes you through the days in the calendar,
rather than returning you to the Home Page (See screenshot 1)
↳ User did not like where the back button was, and admitted he would not have
found that himself – he found it very confusing and thought it was rather small to
see.
↳ User thought the colour scheme and layout was relatively OK.

Screenshot 1

Schedule
Wed, Mar 22, 2017

17:02
0 - 0 Ibuprofen

User thought this button would take him back to the Home Page
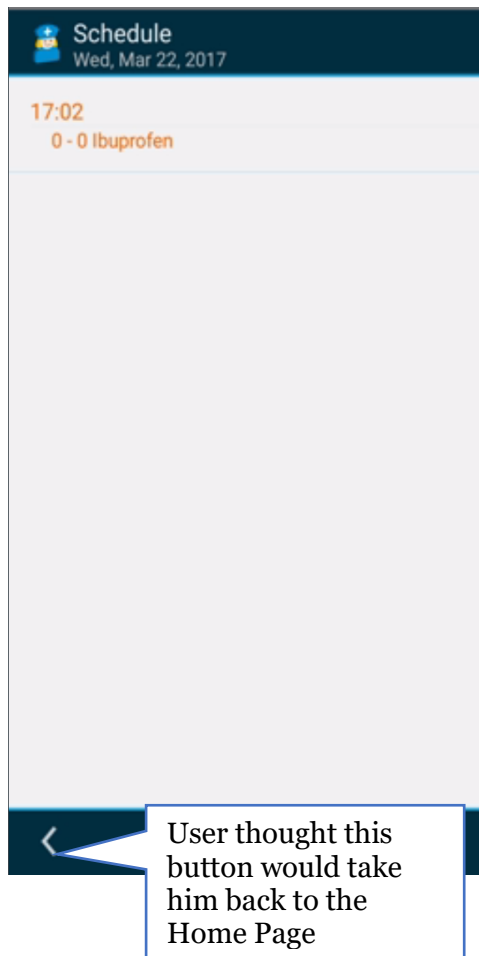
Medisafe:

↳ User was very confused on how to get off the pop-up, to get back to the home page (See Screenshot 2)

↳ Was not sure at all how to add a new medication (See screenshot 3). User did not see any opportunity to add a new medication on this page, or on the home page. Whereas, this is available for the user to do by clicking on the red plus button at the bottom right hand side of the page.

↳ User struggled a lot with this application.

Screenshot 2
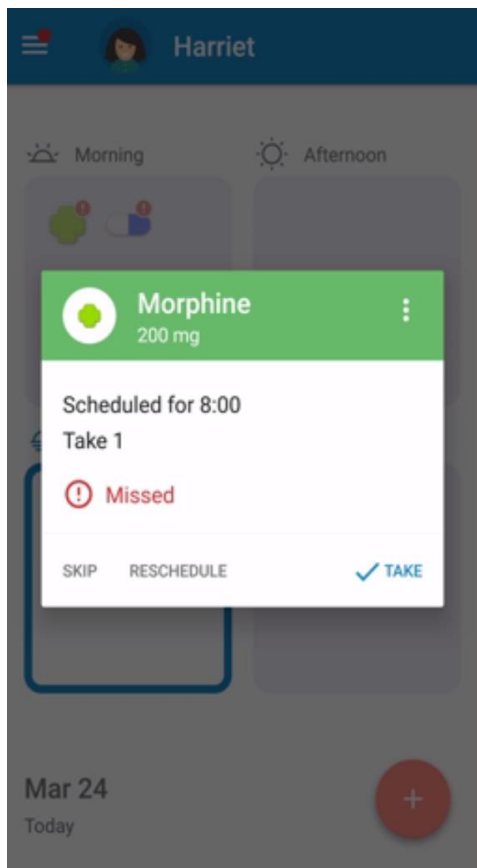
Screenshot 3
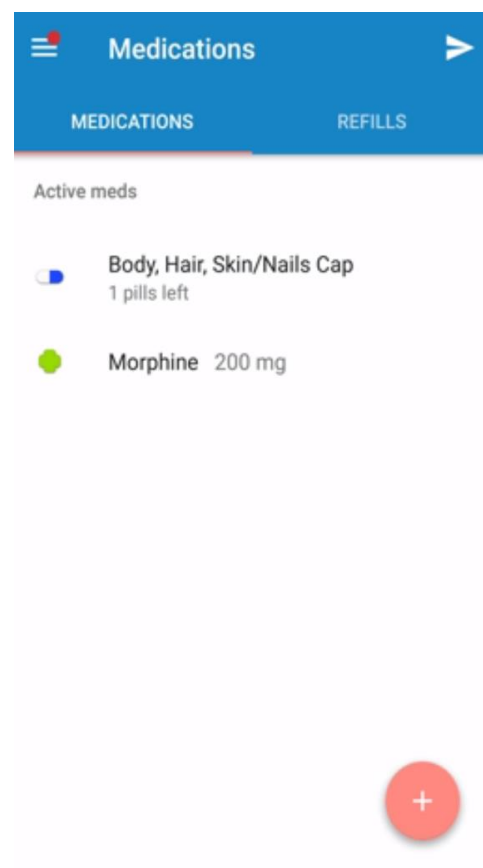
3.7 Functionality and Usability of Existing Applications

As discovered through researching current applications in the Apple Store and Play Store, there are not many current widely known apps that measure mobility and vital signs. There is one application that stuck out as a relatively appropriate application that measures mobility and vital signs. This app has been specifically made for active adults who want to keep track of their fitness levels. However, there are aspects of the application that could be modified to be applicable for the elderly users of the target audience.
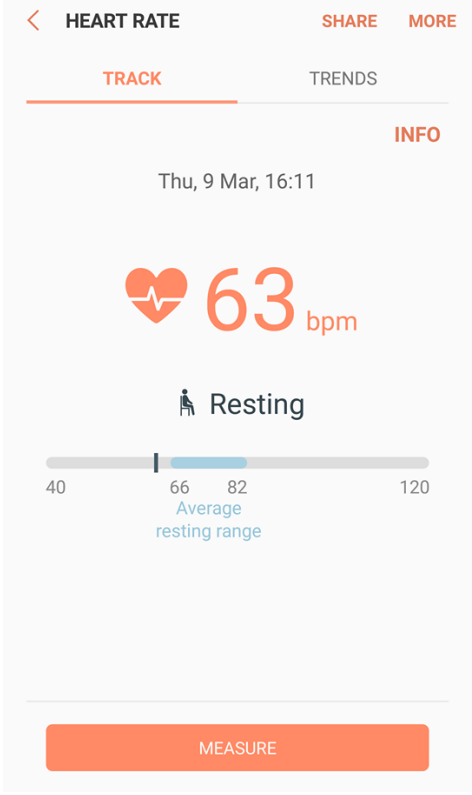
The application chosen to be analysed is S Health version 5.6 [16].
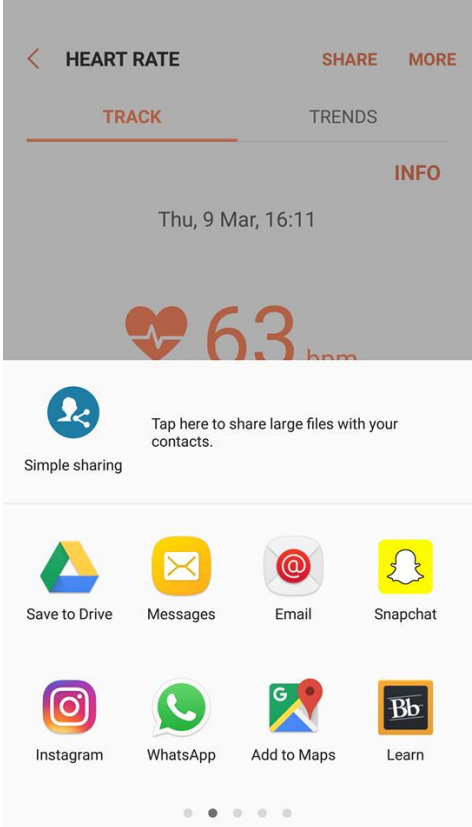
Features of SHealth relevant to the project
- Manages health and environmental records such as heart rate, blood pressure, blood glucose levels, stress, weight & Sp02
- Manages fitness activities
- Notifies you if you have not done any activity for the day
- Easily send daily activity to recipients
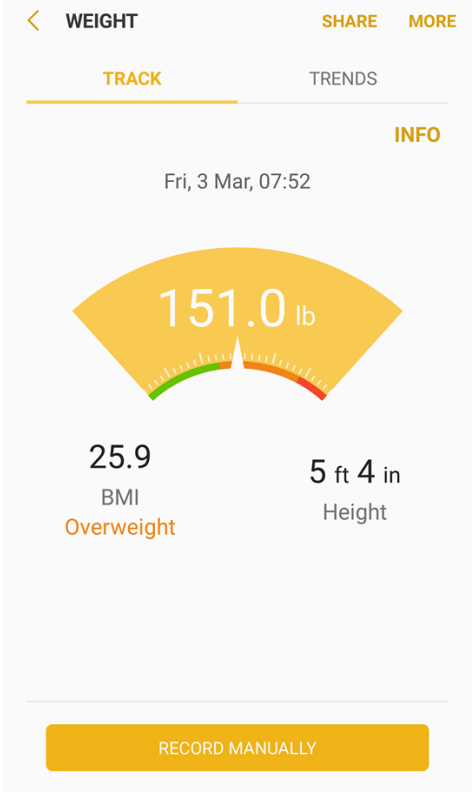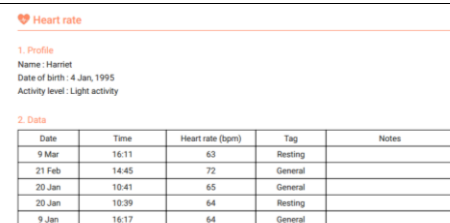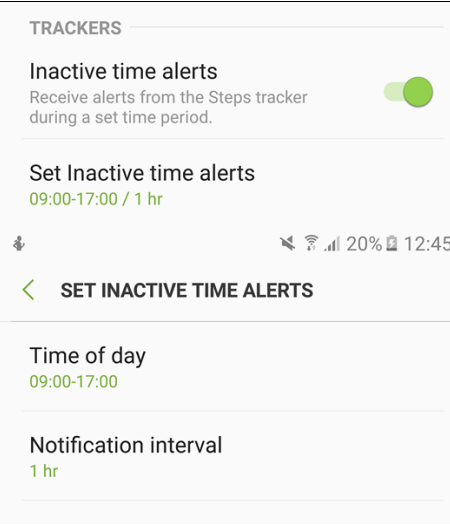
Below, an analysis of the functions of SHealth and their applicability to the project using the MoSCoW method will be undertaken. MoSCoW is a technique used to determine the priorities for each requirement in the application. It stands for "Must Have, Should Have, Could Have and Won't Have" priorities. Further definition of MoSCoW is described in Chapter: 4.2 Gap Analysis.

Function	MoSCoW	Justification	Adaptations needed	Supporting Evidence
Records daily activity	Must have	Recording the user's daily activity is one of the most important features necessary for the project. From the Questionnaire Analysis, 72% of respondents agreed that it is vital that mobility is tracked to ensure that if the patient is wandering outside the house or up and about their house at odd hours of the day, that they should be monitored and alerts should be sent to the family members of the individual.	It is important that the tracker is even more sensitive, as SHealth currently uses its mobility tracker as a method for tracking how far users have walked outside of their house. The elderly users will not be as active, and need to be monitored from inside their house. Monitoring such as walking outside the house or not doing any activity (assuming the user has not got out of bed for the day), will be the most important features of the mobility tracker.	*Figure 21: Regularly measures the user's activity for the day*

| Manage heart rate, blood pressure and blood glucose | Must have | One of the main features identified for the application is to be able to monitor the patient's heart rate. This is important to ensure there are no fluctuations or changes to the user's vitals after being discharged from hospital. It is also important that the patient can manage their own heart rate, so that they do not need to rely on District Nurses/Carers to take their heart rate measurements everyday if this is a necessary requirement for their recovery. | Due to not having any external equipment, the heart rate measurements will not be as accurate as they could be. If necessary, the app could incorporate a Wireless Blood Pressure Monitor that would allow the user to measure more effectively. A good example of a similar technology already is available from Withings. It can be quite difficult for the user to place their finger on the sensor for almost one minute, and the sensor can become quite hot if it takes a long time. This would need to be adapted so that it is more user friendly. |

Figure 22: Feature for measuring user's heart rate |

| Sharing information with others via email | Must have | Based on the analysis from the questionnaire results, most users felt it would be important to be able to send information the user's family, doctor or social worker. This application has the ability to share. | Currently when you select 'Share' in the application, it takes you to the OS specific options to share information. This could confuse our target audience, as there will only be a limited number of people they would want to share the information with. Therefore, there could be tailored options for the user to select from, which are set up when the application is used for the first time. | |

Figure 23: Pop-up that is presented when the user presses 'Share'

Track weight	Could have	This is not a feature that is necessary for the application, however it would be desirable. It would be good to know if the patient is still eating when they are at home – if they are not getting food providing to them like they did at the hospital, the app will help them to control their weight.	Currently can only view the weight in pounds. A feature allowing the user to set up their preferred method for measurement would be preferable.	*Figure 24: Where the user can enter in their weight, and can click on trends to see how much they have gained/lost over the previous days/weeks/months*

View trends for all trackers	Should have	Currently users can see the daily/weekly/monthly trends for their activities. This would be useful, specifically for the vital recordings to be able to view the history and see the average of their recordings. From the questionnaire analysis, 55.6% of respondents thought this would be a necessary feature of the application.	Cannot currently share all the features with others. You can currently export your heart rate and blood pressure to a PDF, xls or HTML document. However, you cannot do this for weight or step count.	*Figure 25: Exported information for user's heart rate*
Reminders	Should have	It is an important feature that the elderly users have alerts to remind them when to be more active or to remind them to measure their daily vitals. In the Carers questionnaire, all the respondents selected the option for the application to have daily reminders to ensure the correct vitals have been checked. This is clearly a feature that they feel would be necessary.	You can currently select notification reminders to let you know you have been inactive for a certain amount of time. This is a great feature that is implemented already. There are no current reminder options for any vital trackers. The app is not customisable in this sense.	*Figure 26: Current options for reminder notifications*

Figure 27: Notifications that pop-up on your phone if you have been inactive for a certain amount of time

Track sleeping patterns	Would like	This feature is not a necessary function required for the elderly person's care. If this was to be implemented, it would be an extra non-functional requirement.	Currently the application monitors when the user's phone is inactive and estimates the length of time the user has slept. The times can be changed if inaccurate, and the user can rate how well they slept. The user can view trends over the days/weeks/months to see if their sleeping pattern is regular. No adaptations would be necessary for this feature	
No internet connection required	Must have	This feature would be very useful for elderly patients. Many will be new to technology, therefore may not have an internet connection. Therefore, we do not want this to hinder the usage of the app. Inactivity, activity, vitals and all other functions can be input without an internet	None	

		connection. The only feature that would need an Internet connection is if the user needs to email their results to their GP/Social Worker.		

4. Requirements Definition

There are several scenarios in which the application could be developed for. There are many functionalities and requirements that have been collected throughout the questionnaire analysis and requirements gathering. Therefore, there is a wide scope for the application. All Must Have requirements are guaranteed to be included in the prototype, to ensure that all aspects are covered and the app has full functionality.

4.1 Scenarios

Scenario 1

The application is created specifically for the Carer of the patient, to be used after major operations that affect mobility, such as hip and knee operations. This would allow the Carer to monitor and check that the patient is doing their exercises and can monitor how active the patient is, and if they are improving over time. It will also allow them to ensure they have taken all their medications at the correct time. The advantage of this, is that the Carer will have full responsibility and understanding of the app, so that the patient does not have to worry about using the application incorrectly. It will also allow the Carer to use the app in other scenarios with patients, such as those with Parkinson's Disease or Dementia. The disadvantage of this scenario, is that the patient will not gain independence (which is the main aim of the task). The patient will constantly need to be monitored by their Carer.

Scenario 2

The application is created specifically to those who live alone, and are currently recovering from a major operation such as a knee and hip operation. The patient will still receive Carers sporadically, however if the patient uses the app effectively, this will relieve the pressure on the Carers coming to the home regularly. The advantage of this is that it allows the patient to gain independence and recover quickly. The disadvantage of this is that the patient may feel lonely, and may be concerned if they incorrectly select an option within the application that they do not understand. To relieve this, the application should have an extensive tutorial and help page, as well as the option to communicate with family members, so they do not feel lonely throughout their recovery period where they are very immobile.

Scenario 3

The application is created specifically for people who do not receive any social care after returning from the hospital. This would allow for Carers to focus their efforts on patient's that are completely unable to care for themselves. The advantage of this scenario is that it relieves the pressure on the NHS, and it allows the user to become completely independent of their own care. The disadvantage of this is that the patient may need help getting into bed, the shower or getting clothes on, which are features that the application would never be able to do. The user may also feel very secluded and lonely if they did not have any helpers or visitors after they have recovered from a major operation.

Chosen Scenario
Based on the above scenarios, the main prototype application will be based upon Scenario 2. The main reason for this as it allows the application to be accessible by the patient, however it would not be a replacement for a Carer. The application would be

an addition to allow them to be organised and ensure they are on the right road to recovery. Therefore, when creating the prototype and defining the requirements, it will be ensured that the scenario is adhered to, and applicable features are implemented.
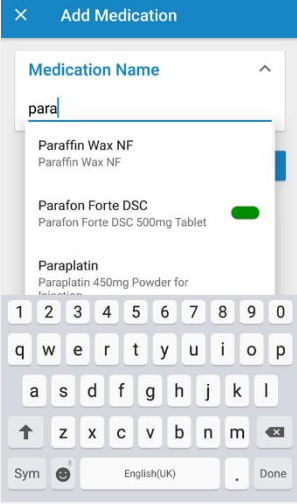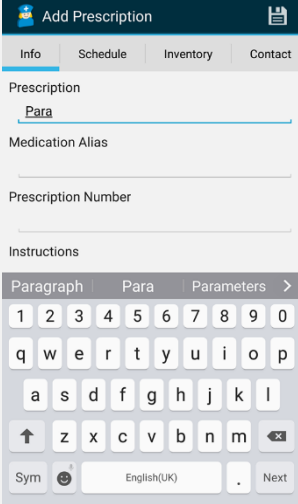
4.2 Gap Analysis

This section will be the gathering of all the non-functional and functional requirements necessary for the prototype of the application. They will be determined based upon all the research undertaken from the interviews, questionnaires, heuristic evaluations and functionality and applicability of similar applications. For the Gap Analysis, the recommendations will be mapped against the applications that have been previously analysed to see where they do not currently meet each of the requirements. Each of the requirements will be identified through using the MoSCoW technique. MoSCoW stands for Must Haves, Should Haves, Could Haves, and Won't Haves. This will allow for prioritisation of requirements during the design of the application prototype. The Must Haves are the critical features, Should Haves are important and should be implemented with a high priority, the Could Haves are minor features that are done if there is enough time, and the Won't Haves are things that would be desirable to have, but would not be able to be implemented within the project time limit. The requirements will be split into non-functional and functional requirements. The functional requirement is those that describe the behaviour of the system, and the non-functional requirements tend to fall under performance characteristics e.g. Accessibility, Efficiency and Privacy. The requirements will also be specified as "Essential" or "Desirable". Essential requirements are those that ensure the project will reach its potential, and delivers all the "Must Have" needs for the application to fulfil its purpose. The "Desirable" are requirements that would be great to implement, providing the timescale allows for it, however these requirements will not affect the quality of the application.
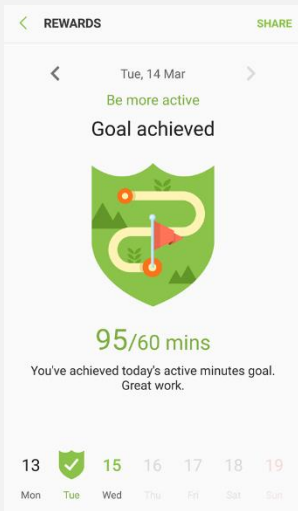
Due to the size of the Gap Analysis, a small sample will be provided. The rest of the Gap Analysis can be found in the appendix.

Sample 1:

ID:	1.2	
Requirement:	The interface could have a list of medications for the user to choose from, as well as typing in their own	
Justification:	It was determined during the heuristic evaluation that it can be quite difficult for the user to type in the entire medication name, especially as many of them have lengthy names, without there being suggestions for the user to select.	
Acceptance Criteria:	The interface displays a list of relevant medication names when the user has typed in the first three letters of the medication name	
Priority:	Desirable	
Med Helper/Medisafe compliance:	Medisafe is compliant:	Med Helper is not compliant:

When the user types in the name of the medication, options are suggested	No options are suggested when the user starts to type in the name of their medication

Sample 2:

ID:	2.3
Requirement:	The interface could have an audio confirmation when the user has been active for the target they set as their daily active task.
Justification:	To help provide users who are not as "tech-savvy" a confirmation that they are completing the tasks correctly. If a positive
Acceptance Criteria:	The system should provide an alert of positive feedback when the user reaches their daily target
Priority:	Desirable
S Health compliance:	S Health is compliant. When the user reaches their daily step target, they alert the user with a notification and a positive sound chime.

Sample 3:

ID:	3.3
Requirement:	The system could have auditory commentary on how to complete tasks
Justification:	"Approximately one in three people between the ages of 65 and 74 has hearing loss and nearly half of those older than 75 have difficulty hearing" [17]. Therefore, it would be beneficial for the application to have a feature where the user can select a button for auditory commentary to tell them how to complete the tasks e.g. throughout measuring the vitals, if they are not completing the recording properly, an auditory voice could alert them to let them know to place their finger correctly on the sensor.
Acceptance Criteria:	The interface has a button the user can click when they want audio commentary turned on
Priority:	Desirable
S Health compliance:	S Health is not compliant. They currently only have text to explain how to complete tasks.

Sample 4:

ID:	4.7
Requirement:	The system must ensure reminders users have set up are always presented
Justification:	It is vital that reminders that are set up are always shown. If there is a time that a reminder is not presented, this could affect the user's health as they may forget to take a medication, which could affect them in many ways that could compromise their recovery.
Acceptance Criteria:	The application must present the reminder when the user has set up the reminder for. If the smartphone is turned off, reminders must present as soon as the smartphone is turned on, even if the application is not open.
Priority:	Desirable

Sample 5:

ID:	5.2
Requirement:	The interface must be simple, easy to navigate and user-friendly
Justification:	In the medical questionnaire, on Question 15, 14 out of 18 respondents thought that it would be appropriate for the target audience that the application has simple navigation, and 16 out of 18 thought that a simple design would be appropriate. This will help to adhere to Nielsen's heuristics of Aesthetic and Minimalist Design.

Acceptance Criteria:	The interface must not contain any redundant data and use concise, easy to understand text and options for navigation
Priority:	Essential

4.3 Gathered Requirements

Here are the final defined requirements based on all the gathered research and analysis. These requirements will be used and adhered to when designing the prototype application.

1. Medical Reminder requirements:
   1.1 The interface must display when a notification when the user has not taken their medication
   1.2 The interface should have a list of medications for the user to choose from, as well as typing in their own
   1.3 The interface should have images of the medications
   1.4 The interface must have a calendar feature
   1.5 The interface must alert users to take their medicine at their specific chosen reminder time
   1.6 The interface should allow users to have refill reminders

2. Mobility requirements:
   2.1 The interface must provide an option for user's permission to track user's mobility at all times
   2.2 The interface must record the user's daily activity and be sensitive to movement around the house
   2.3 The interface could have an audio confirmation when the user has been active for their time necessary.
   2.4 The system must be linked to the user's family member's application, to alert them of the user's activity if it is unusual

3. Vital tracking requirements:
   3.1 The interface must provide accurate measurement methods for vitals to be tracked
   3.2 The system must alert users if they are not correctly using the vital tracker
   3.3 The system could have auditory commentary on how to complete tasks

4. General application requirements:
   4.1 The interface must allow the user to share data with their specified health professional
   4.2 The application must adhere to the Data Protection Act
   4.3 The system should provide a tutorial on how to use the application
   4.4 The system should be able to record and monitor measurements without an internet connection
   4.5 The manufacturer of the application must inform users of the data they collect, and inform them of any potential privacy issues they may be concerned with
   4.6 The system should have a feature that allows users to track and view trends/history for all measurements collected

4.7 The system must ensure reminders users have set up are always presented

4.8 The text size should be altered for the user's preference and settings should remain when the app is next re-opened

4.9 The interface won't have an exit feature

4.10　　　　The interface should provide guidance when the user requests it

4.11 The system should allow users to log in to their account with authorised login credentials

4.12 The system could allow users to view their medical record history

5. <u>Non-Functional requirements:</u>

   5.1 The interface should have large icons

   5.2 The interface must be simple, easy to navigate and user-friendly

   5.3 All icons should be self-explanatory and consistently placed within the system

   5.4 The system must limit the usage of multi-touch gestures

   5.5 The user should have the option to change the colour scheme in the application

   5.6 The system must be secure and encrypted

   5.7 The system won't replace Carers/social workers

   5.8 The system should run error free

5. <u>Solution Design</u>

Now that the requirements have been defined, the design of the application can be created. The prototype will be an interactive wireframe created on Axure [18]. Axure is the software of choice as it allows you to create a very powerful interactive wireframe without any coding necessary. Axure also allows you to easily create wireframes that can be easily shown and created for mobile devices, which is the main aspect for choosing this software for this project.

<u>App User Flow</u>
To help with the structure of the mobile application, a User Flow diagram has been created to help represent how each page flows between each other. This will make for easier creation and navigation for the application.
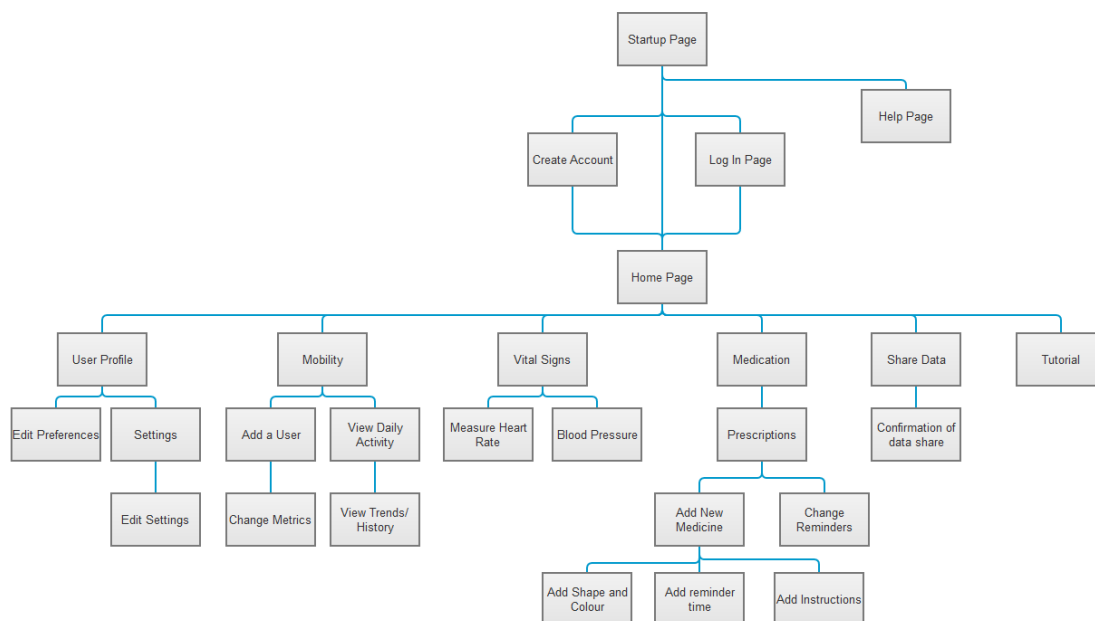
5.1 Interface Design

The design of the user interface is a vital part of the application. It needs to adhere to all the relevant requirements, and must be user-friendly and easily accessible for elderly users who do not use technological devices and applications in their everyday life.

<u>Wireframes</u>
Wireframes will be created to represent the user interface of what the application could look like. The wireframes were created with Axure.

<u>Activity Diagrams</u>
UML Activity diagrams represent the flow from one activity to another. In this case, the activity diagrams represent the flow of actions the application would need to take to reach the task destination. This helps to show the sequence of the use cases within the application. The activity diagrams were created on Visual Paradigm.

<u>Use Cases</u>
Use Cases have been created to help determine the main tasks within the system. The use cases help to document how each task will operate within the application, and the process of completing the action. Use cases define the pre-and post-conditions that are

necessary for completing the tasks, as well as the basic and alternative flows that can be undertaken to complete the task.

1. *User login*

The User Login page is where the users sign in, to enable them to use the app. The user must log in to view their saved and previous history of using the application. The user must have registered before logging in for the first time.

<u>Wireframe:</u>

Figure 28: Log in Page

<u>Activity Diagram:</u>

Use Case:

Use Case Name:	User Login
User type:	Patient, Admin, Carer
Description:	The user will navigate the system to input their username and password
Pre-conditions:	User has a registered account
Basic Flow:	1. User selects 'Log In' on the start-up page 2. User enters their username into the relevant input box 3. User enters their password into the relevant input box 4. User selects 'Submit' to submit details 5. User gains authorised access and is redirected to the homepage
Alternative Flow 1:	1. User selects 'Log In' on the start-up page 2. User inputs incorrect username and/or password 3. User is displayed an error message informing them of incorrect details 4. User must re-enter username and password 5. User selects 'Submit' button 6. User gains authorised access and is directed to the homepage
Alternative Flow 2:	1. User selects 'Log In' on the start-up page 2. User enters in their password incorrectly 3. User selects Submit

	4. User selects 'I have forgotten my password'
	5. User creates a new password
	6. User is returned to Log In page
	7. User re-enters login and password details correctly
	8. User selects 'Submit' button
	9. User gains authorised access and is directed to the homepage
Post- conditions:	The user is logged in, with their relevant saved medicines and user data corresponded to on the homepage.

2. Create account

The user must create an account when they open the application for the first time. This ensures they have a log in and password for the following times they use the application.

Wireframe:

Figure 29: Create an Account

Activity Diagram:

Use Case:

Use Case Name:	Create Account
User type:	Patient, Admin, Carer/Doctor
Description:	The user must create an account before they can use the application
Pre-conditions:	The user has access to the start-up page
Basic Flow:	1. The user selects 'Register' on the start-up page 2. User enters a memorable username into the relevant field 3. User enters a memorable password into the relevant field 4. User enters their date of birth into the relevant fields 5. User selects the Terms and Conditions checkbox

	6. User selects the submit button
	7. User receives an authorised account, and is in logged in
	8. User is directed to the homepage
Alternative Flow 1:	1. The user selects Register on the start-up page
	2. User enters in username that has already been taken by another user
	3. User selects Submit
	4. An error message will be presented, informing the user of invalid data entry
	5. User changes username and enters in valid details
	6. User selects submit button
	7. User receives an authorised account, and is logged in
	8. User is directed to the homepage
Alternative Flow 2:	1. The user selects Register on the start-up page
	2. User enters in valid details into relevant username, password and date of birth fields
	3. User selects Terms and Conditions
	4. User is directed to the Terms and Conditions page
	5. User returns to log in page
	6. User must tick Terms and Conditions box to create an account
	7. User selects Submit
	8. User account is created, and is logged in to the system
Post-conditions:	User is directed to the homepage with an optional tutorial

3. Help Page

The help page is available for when the users are struggling to use the application. The help page contains information to provide assistance, when the user is having problems with the app.

Wireframe:

Help Page

Frequently Asked Questions:

This section will include Help and Documentation for the users to view. Support and video tutorials will be available.
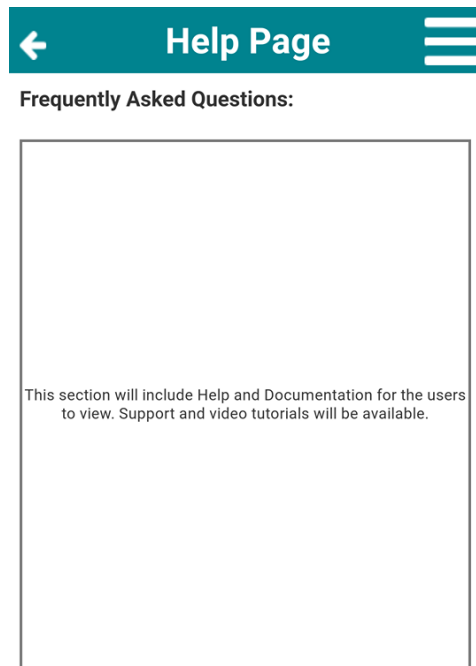
Figure 30: Help Page

Activity Diagram:

User selects the Question Mark

Pop-up is displayed

User selects the Question Mark

User logs in with authorised account details

Use Case:

Use Case Name:	Help
User type:	Patient, Doctor/Carer, Admin
Description:	There will be access to the help page on the start-up page
Pre-conditions:	The user has access to the start-up page
Basic Flow:	1. The user presses the question mark 2. A pop-up explaining what the user can do on the page is displayed 3. User presses the question mark to hide the pop-up 4. User logs in/registers with the necessary help provided
Alternative Flow 1:	1. The user presses the question mark 2. The user selects the pop-up 3. The pop-up directs the user to an extensive help page 4. The user returns to the start-up page 5. The user logs in/registers with necessary help provided
Post-conditions:	The user is logged in and directed to the homepage

4. View Daily Medication

This page updates daily and allows the user to view and tick off the medications that they have taken throughout the day.

Wireframe:

Figure 31: Medication Tracking

Activity Diagram:

Use Case:

Use Case Name:	View daily medication
User type:	Patient, Doctor/Carer
Description:	The user will be able to see all the medications that they must take for the current day
Pre-conditions:	The user is logged in The user must have input at least one medication to have on that day
Basic Flow:	1. The user selects Medication Tracking 2. The user can see the daily medications that they need to take, and at what time 3. User can select those that have already been taken
Post-conditions:	The user can see a detailed view of the medication they need to take for the current day

5. User update details
This page allows the user to update their name, date of birth and tracking settings.

Wireframe:

Figure 32: User Profile

Activity Diagram:

Use Case:

Use Case Name:	User update details
User type:	Patient
Description:	The user may want to change their username and password, or other personal details
Pre-conditions:	The user is logged in with an authorised account
Basic Flow:	1. The user selects the icon of the User in the top right corner of the Home Page 2. The user is provided with current details and input boxes to change the information 3. The user puts desired details into one or more of the input boxes 4. User selects Save button
Alternative Flow 1:	1. User selects the icon of the User in the top right corner of the Home Page 2. The user is provided with current details and input boxes to change the information 3. The user puts incorrect data into the input fields 4. An error message is presented, to ensure the user to fill in the fields so they match the criteria provided 5. The user re-enters information 6. The user selects save
Post-conditions:	The user's personal details are updated

Add reminders
On this page, the user can add reminders to notify them to take their medications at the correct times.

Wireframe:
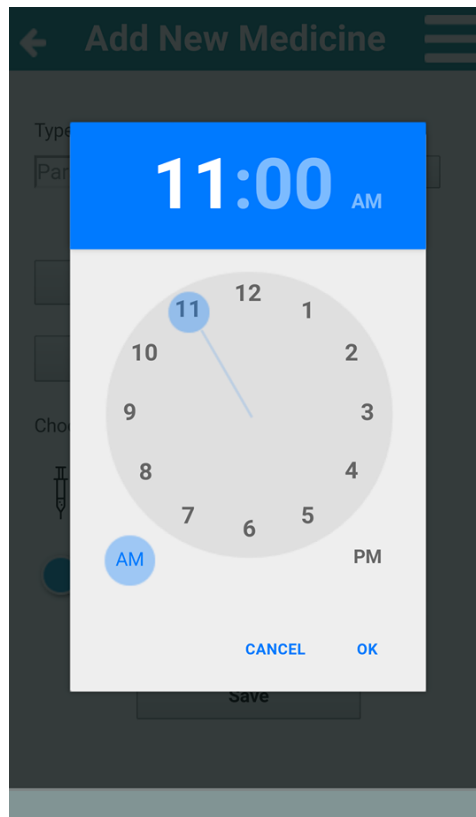
Figure 33: Add reminder time

Activity Diagram:

Use Case:

Use Case Name:	User adds a reminder on a current medication
User type:	Patient
Description:	The user will need to set phone reminders to alert them to take their medication at specific times of the day
Pre-conditions:	The user has logged in to an authorised account The user has at least one medication logged already
Basic Flow:	1. The user selects the Medication Tracking option on the Home Page 2. The user selects the medication they want to add a reminder to 3. The user is presented with current information with selected medication 4. User adds a time and which days to be reminded for 5. User sets the alarm they want to be used to alert them 6. User selects save

Post-conditions:	User reminder is saved

Measure Heart Rate

This page allows the user to measure their heart rate through the sensors on the phone.

<u>Wireframe:</u>

Figure 34: Measure heart rate

<u>Activity Diagram:</u>

Use Case:

Use Case Name:	User measure heart rate
User type:	Patient
Description:	The user can measure their own heart rate without any extra equipment
Pre-conditions:	The user has logged in with an authorised account
Basic Flow:	1. The user selects Vital Signs on the Home Page 2. User selects button 'press here to measure your heart rate' 3. User is prompted with a message telling them to press their finger on the image until they are prompted to stop 4. The system tells the user their heart rate measurement
Alternative Flow 1:	1. The user selects Vital Signs on the Home Page 2. User selects button 'press here to measure your heart rate' 3. User is prompted with a message telling them to press their finger on the image until they are prompted to stop 4. The user takes their finger off the image before it the heart rate has been measured

		5. The system will stop to measure the users heart rate, and an error message will show 6. The user must re-start and press down again until prompted to stop 7. The system tells the user their heart rate measurement
Post-conditions:		The users heart rate is saved into the system

View trends (Heart Rate)

This is where the user can view the trends of their heart rate in a graphical form, from the previous days/weeks/months.

Wireframe:
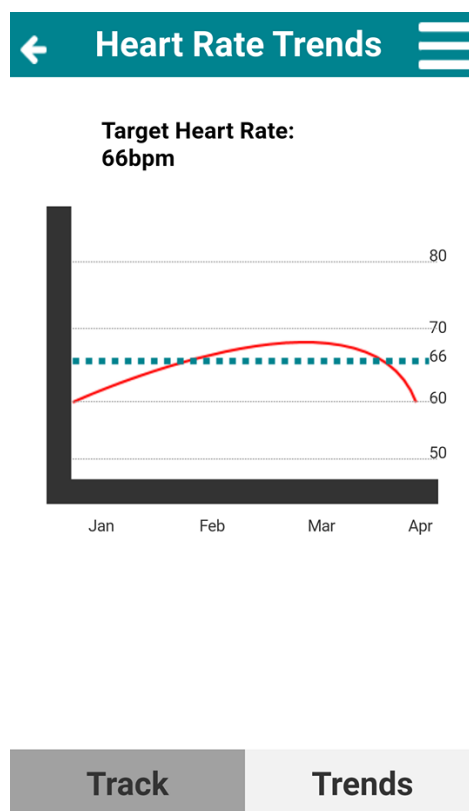
Figure 35: Heart Rate Trends

Activity Diagram:

Use Case:

Use Case Name:	User measure heart rate
User type:	Patient
Description:	The user can measure their own heart rate without any extra equipment
Pre-conditions:	The user has logged in with an authorised account
Basic Flow:	1. The user selects Vital Signs on the Home Page 2. User selects button 'press here to measure your heart rate' 3. User is prompted with a message telling them to press their finger on the image until they are prompted to stop 4. The system tells the user their heart rate measurement
Alternative Flow 1:	1. The user selects Vital Signs on the Home Page 2. User selects button 'press here to measure your heart rate' 3. User is prompted with a message telling them to press their finger on the image until they are prompted to stop 4. The user takes their finger off the image before it the heart rate has been measured

	5. The system will stop to measure the users heart rate, and an error message will show
	6. The user must re-start and press down again until prompted to stop
	7. The system tells the user their heart rate measurement
Post-conditions	The users heart rate is saved into the system

Add a medication

This is where the user can add in new medications to their log, determine how often they are to be taken, and when to be reminded. The user can also modify the shape and colour of the medication.

<u>Wireframe:</u>

Figure 36: Add a new medication

<u>Activity Diagram:</u>

Use Case:

Use Case Name:	Add a medication
User type:	Patient
Description:	The user can add their medication in, so they can be reminded to take them
Pre-conditions:	The user has logged in with an authorised account
Basic Flow:	1. The user selects Medication Tracking 2. User selects 'Add a new medication' 3. User types in the medication name 4. User adds any reminders and instructions 5. User presses Save
Alternative Flow 1:	1. User selects Medication Tracking 2. User selects 'View Prescriptions' 3. 'Add a new medication' 4. User types in the medication name 5. User adds any reminders and instructions 6. User presses Save

| Post-conditions | User's medication preferences have been saved. |
| | User is returned to the homepage |

Change text size
This allows for the user to change the size of the font in the application.

Wireframe:
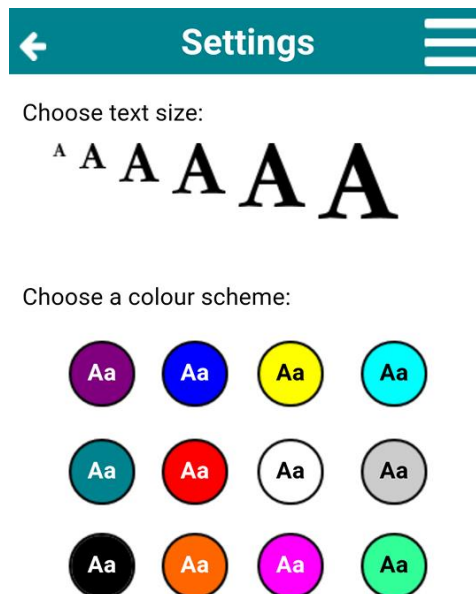
Figure 37: Change text size

Activity Diagram:
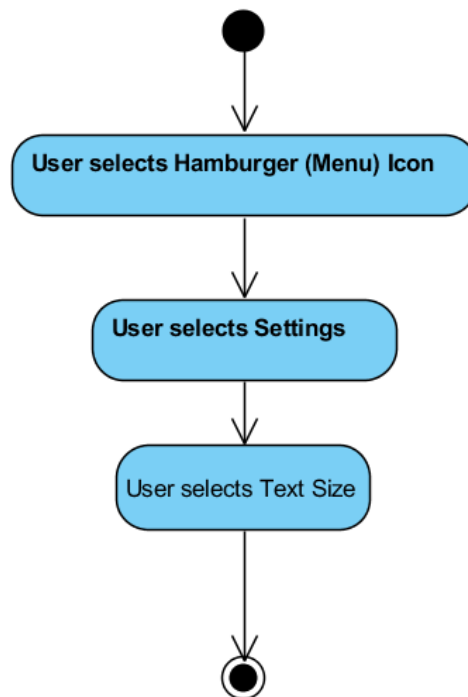
Use Case:

Use Case Name:	Change text size
User type:	Patient
Description:	There are a lot of elderly people who struggle to read text off a screen, therefore there is a feature that allows them to select to change the size of the text on the screen.
Pre-conditions:	The user has logged in with an authorised account
Basic Flow:	1. User selects menu button in top right corner of home page 2. User selects 'Settings' 3. User choose text size
Post-conditions	Text size changes for entire application

Add a User
This is where the user can add other users, so they can share information easily with them.

Wireframe:

Figure 38: Add a User

Activity Diagram:

Use Case:

Use Case Name:	Add a user
User type:	Patient
Description:	The user can add people to their contacts within the app, so that they can easily share information with them.
Pre-conditions:	The user has logged on with an authorised account
Basic Flow:	1. The user selects the navigation icon at the top right corner of the home page 2. The user selects 'Add a User' 3. User enters in personal details for the user they want to add 4. User selects Save
Alternative Flow 1:	1. The user selects Mobility 2. User selects cog in top right corner of page 3. User enters in personal details for the user they want to add 4. User selects Save
Alternative Flow 2:	1. The use selects Medication Tracking 2. User selects cog in top right corner of page 3. User enters in personal details for the user they want to add

	4. User selects Save
Post-conditions:	The user will receive confirmation of the user added

Change colour scheme

This allows the user to choose a colour scheme for the entire application. Allowing the user to tailor the background and text colour to their preference.
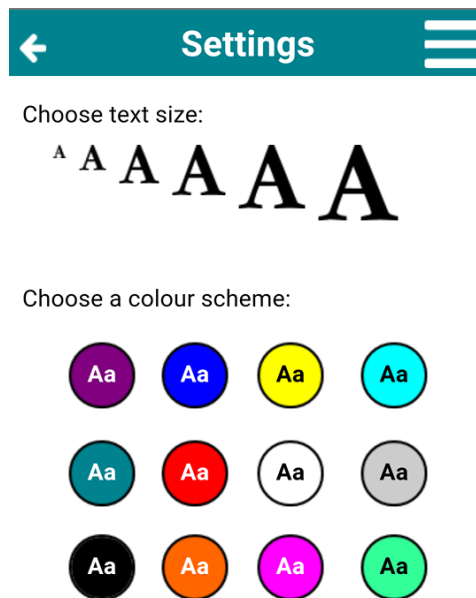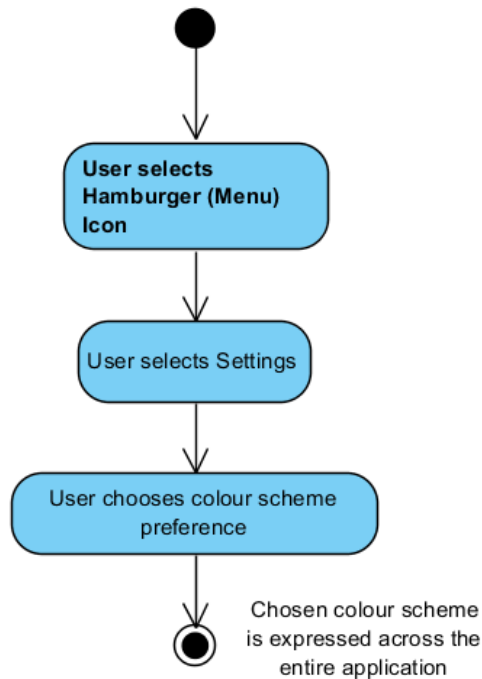
Wireframe:

Figure 39: Change colour scheme

Activity Diagram:

Chosen colour scheme is expressed across the entire application

Use Case:

Use Case Name:	Change colour scheme
User type:	Patient
Description:	Due to the target audience, some may struggle to see certain colours on the screen, therefore giving them the option to change the colour scheme in the application is a must have feature
Pre-conditions:	The user has logged on with an authorised account
Basic Flow:	1. User selects menu button in top right corner of home page 2. User selects 'Settings' 3. User choose colours they want for the application
Post-conditions:	Colour scheme changes for entire application

5.2 Prototype Design

Before starting any design for the application, the size of the user interface needed to be determined. Based on the available devices for testing the application, the design was created for a Samsung Galaxy S6 Android phone. This was determined using https://material.io/devices/ , which provided the measurements for the device.
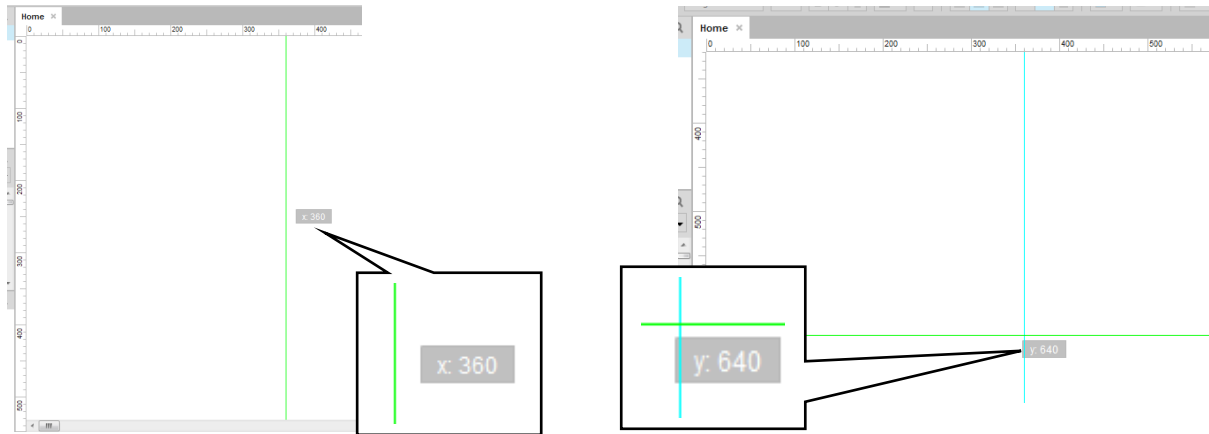
Figure 40: Determining the dimensions -360x640
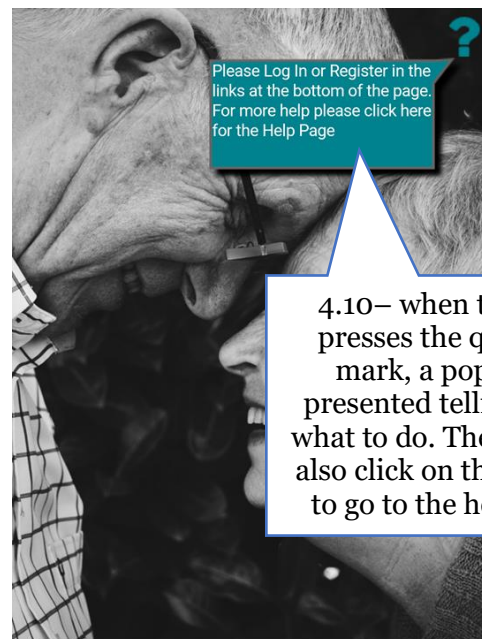
Figure 41: Start-up page

When the user opens the application, they will be asked to Log in or Register. This adheres to requirement numbers 4.11, which states that "the system should allow users to log in to their account with authorised log in details". If the user is using the

application for the first time, they will need to register their details, so they can log on easily next time, and all their saved medical details will be presented.

Figure 42: Create an Account

The user must register their details to use the app. This is based upon the requirement to keep user's details confidential through the Data Protection Act (4.2). To adhere to (4.11), this feature is mandatory for first time users. The question mark buttons are also available for every field the user must fill in. If the user selects a question mark when one is already open, that previous one will close. This is to ensure there is no overlap of the pop-ups.

Figure 43: Login page

Once the user has registered, they can use the details they chose to log in every other time they use the application. The most important reason for having users log in every time they use the app is for confidentiality reasons (4.2). If the user does not enter the correct credentials, an error message will occur to let them know they have incorrectly input the details. This adheres to requirement 5.6: The system must be secure and encrypted. The system also allows them to select 'I have forgotten my password', if they cannot remember their username and password.
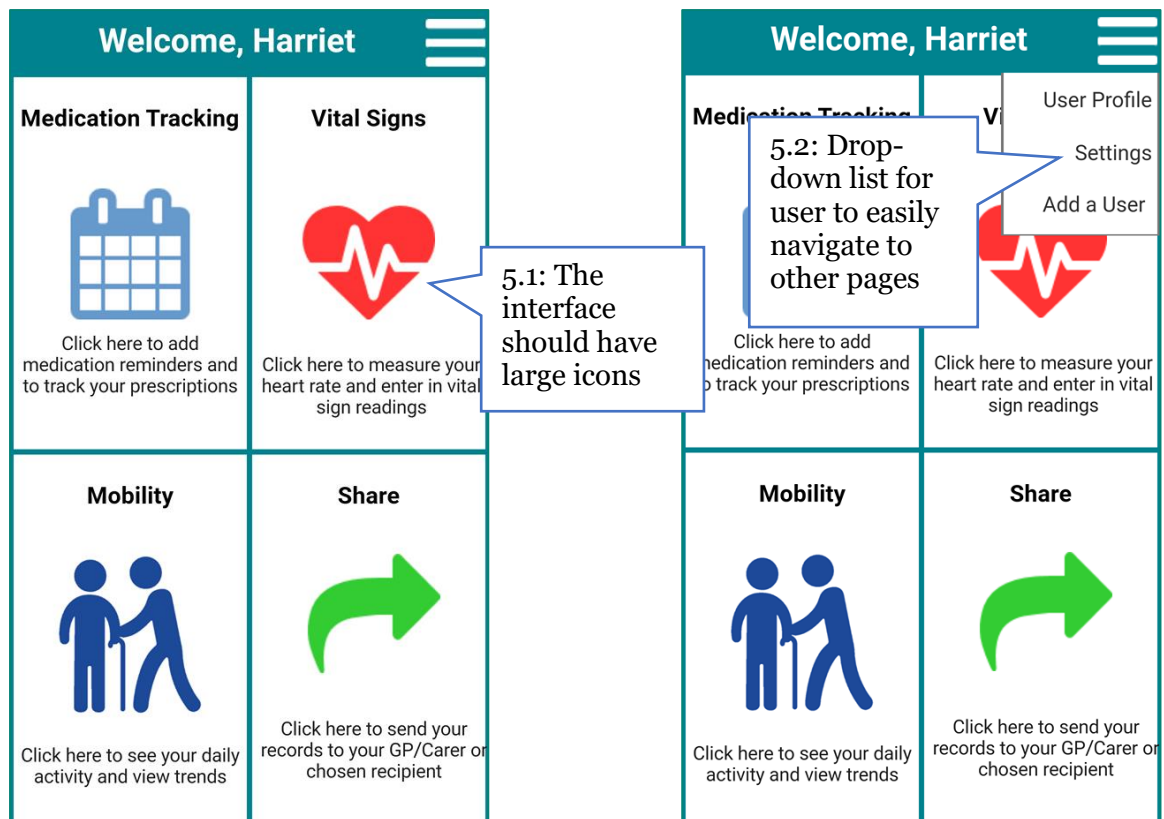
Figure 44: Home Page

The homepage allows the user to access all the functions they would need. Each of the rectangles are links to the pages, making it easier for the user to navigate around the interface. This adheres to the non-functional requirement 5.2, which states that the interface must be simple, easy to navigate, and user friendly.
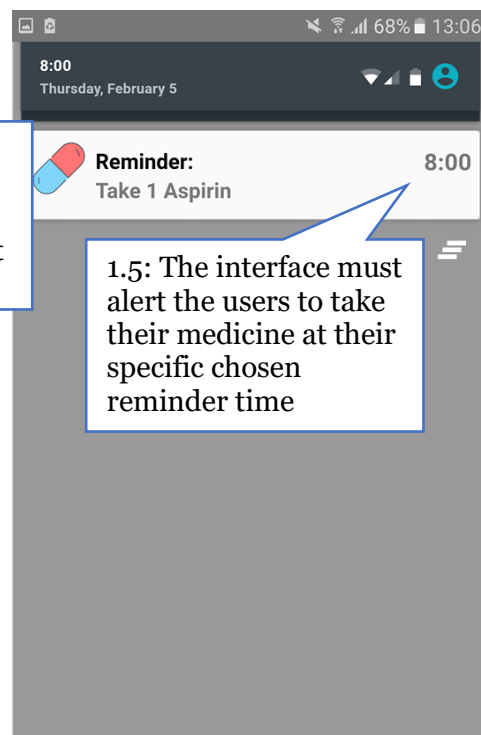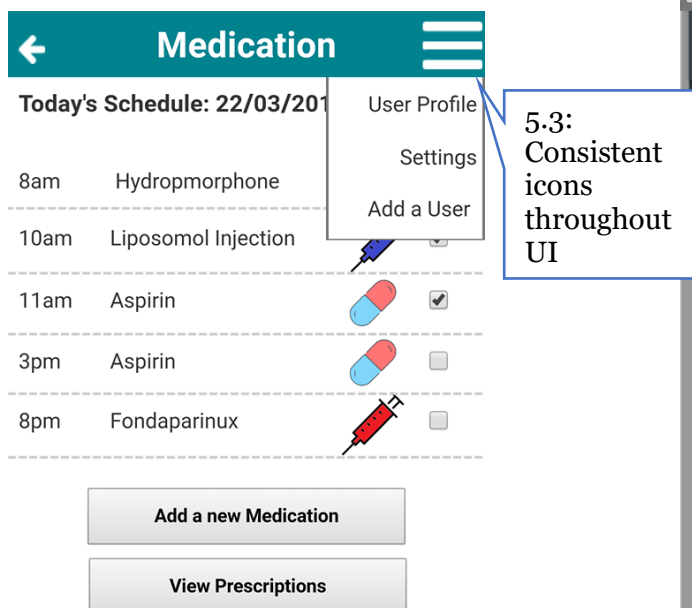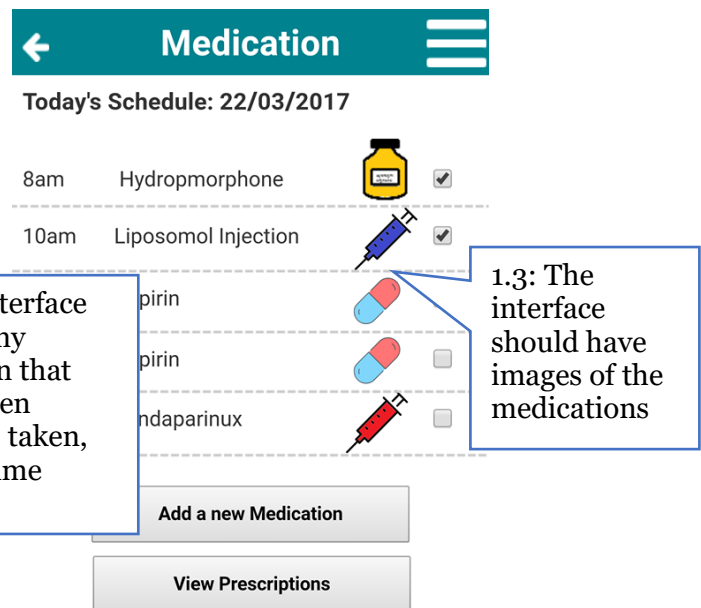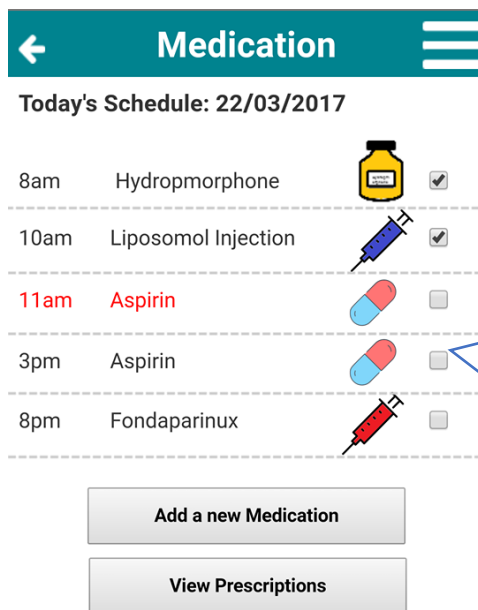
Medication — Today's Schedule: 22/03/2017

Time	Medication		
8am	Hydropmorphone		✓
10am	Liposomol Injection		✓
11am	Aspirin		☐
3pm	Aspirin		☐
8pm	Fondaparinux		☐

Add a new Medication

View Prescriptions

1.1: The interface displays any medication that has not been marked as taken, after the time specified

1.3: The interface should have images of the medications

5.3: Consistent icons throughout UI

User Profile / Settings / Add a User

1.5: The interface must alert the users to take their medicine at their specific chosen reminder time

Reminder: Take 1 Aspirin   8:00

Figure 45: Medication Reminders

The medication page allows users to view their medications and the times that they will be reminded to take their medications. There are images of the medications, to ensure the user knows which medicine to take 1.3. The notification on the mobile device will show up at the relevant time, with an image of the medicine and alert for the user to take their medicine.

Add New Medicine

Type in your medication name below

[   ]   [Search]

Text box for user to type in the name of the medication.

| The | | I | | To | > |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 |

| Q | W | E | R | T | Y | U | I | O | P |

| A | S | D | F | G | H | J | K | L |

↑   Z   X   C   V   B   N   M   ⌫

Sym   ☺   English(UK)   .   Go

Add New Medicine

Type in your medication name below

[par]   [Search]

Paracetamol
Paricaltol
Paraplatin
Parcopa
Paromomycin

1.2: When the user begins to type in the name of their medication, options will be listed below for the user to select

Add New Medicine

Type in your medication name below

[Paracetamol]   [Search]

[Add dates]

[Add times]

Choose colour and shape:

Large buttons consistently shaped with the others throughout the UI

[Save]

Add New Medicine

Type in your medication name below

[Paracetamol]

[Add dates]

[Add times]

Choose colour and shape:

1.3: Allows you to choose a shape and colour for your medication. Easy to understand which is selected, as the selected options will have a red box around the chosen options
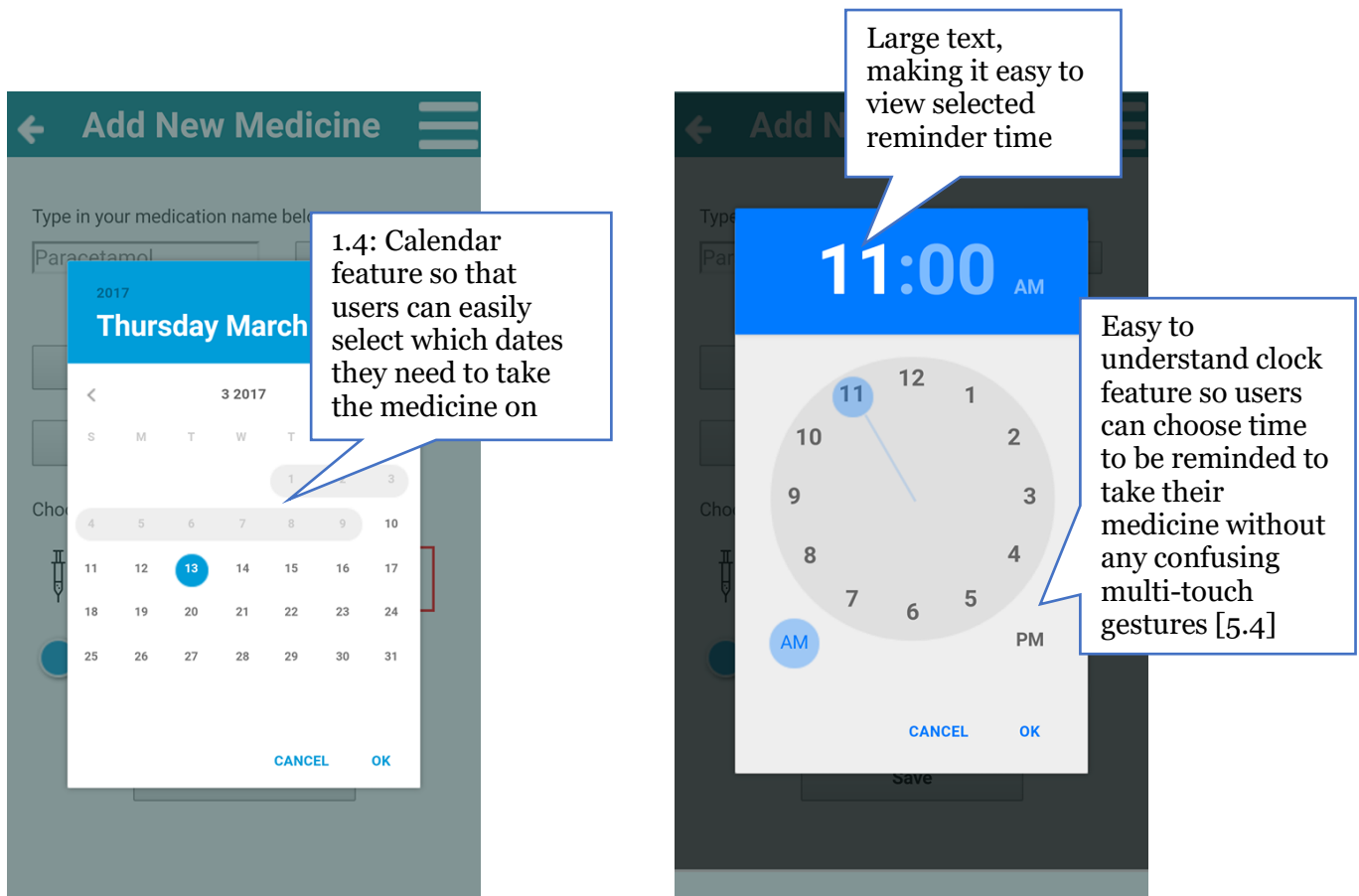
[Save]

1.4: Calendar feature so that users can easily select which dates they need to take the medicine on

Large text, making it easy to view selected reminder time

Easy to understand clock feature so users can choose time to be reminded to take their medicine without any confusing multi-touch gestures [5.4]

Figure 46: Adding new medicine

When adding in a new medicine, there are several steps the user must take, such as choosing the reminder dates and times, colour and shape of medication, and the name of the medication. These features have been made to be accessible and adhere to the relevant requirements.
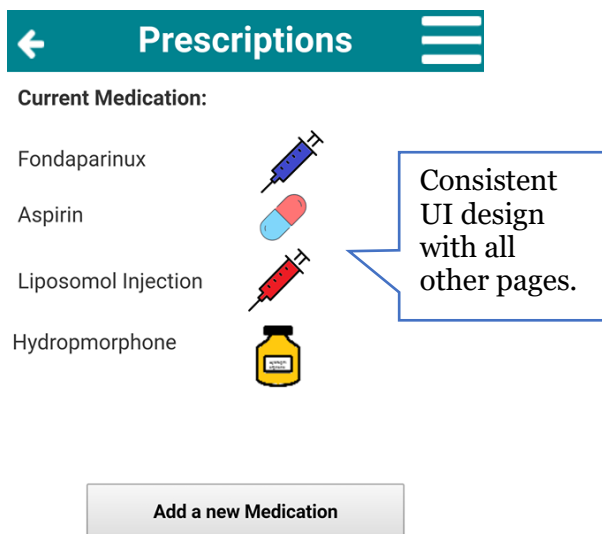

Consistent UI design with all other pages.

Figure 47: View Prescriptions

Here the user can view their current medications that they are taking. When the final medication has been taken, this will be removed automatically from the list. When a new medicine is added, it will automatically be added to the list. A future work for this section is to have it say how many days the user will have to be taking the medication for, and how many they have left until they need to collect more from the pharmacy.

Figure 48: Measuring Vital Signs

It is a great feature for the users to track their vitals. Currently only available for heart rate and blood pressure, however these are the most important things to keep track of

for our users. It will also help to relieve the pressure on their Carer's, as they can just look at the app to get an idea of how the patient is doing, and if they need further monitoring.
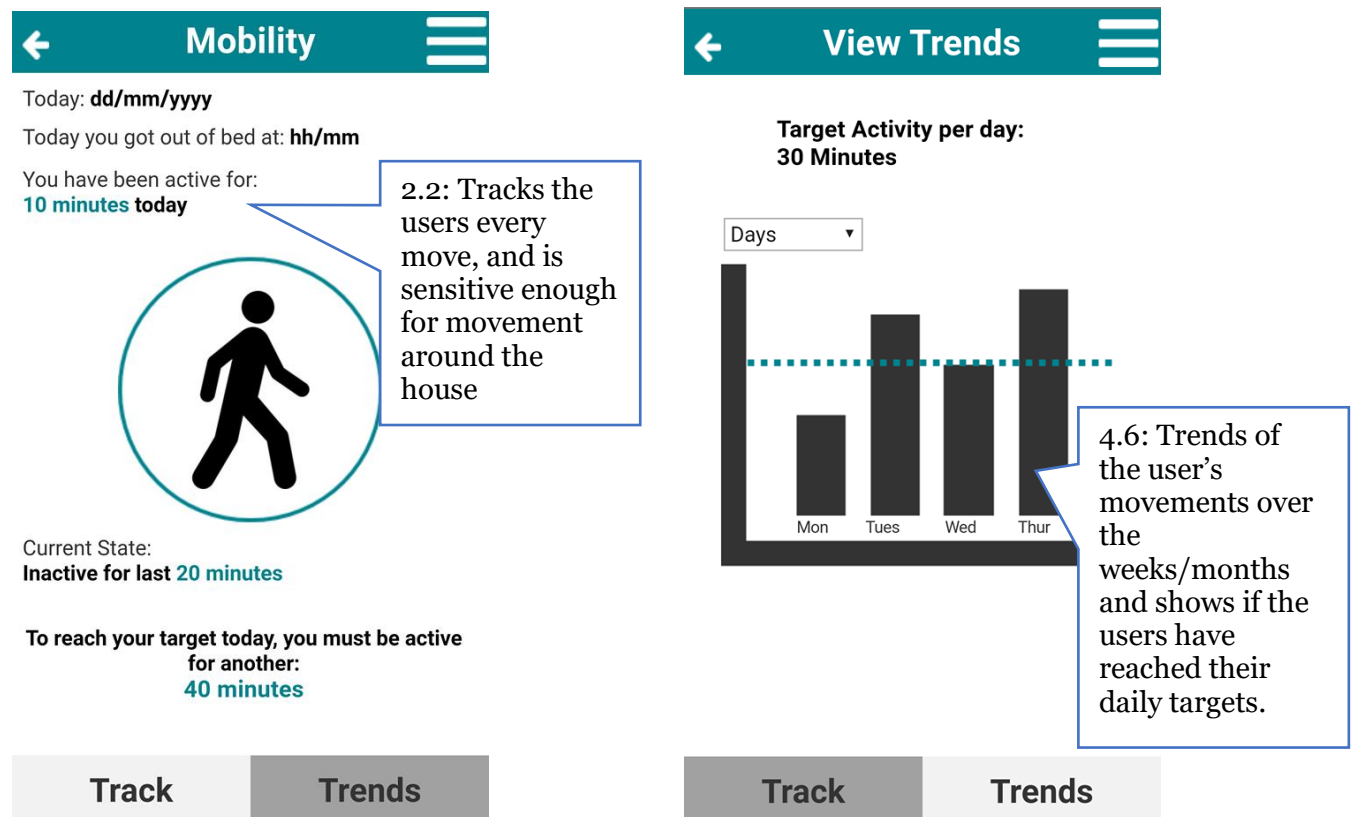
Figure 49: Mobility Tracking

The users do not have to worry about their mobility tracking – the feature updates itself. The tracker will monitor the user's movements, and if the user has not been active for a specific number of hours, or has not got out of bed/the chair for a long amount of time, the user noted as the user's specified primary Carer on the app will be notified of "unusual activity".

Share Data

Select which data you want to share:

Heart Rate Readings
Blood Pressure Readings
Mobility Tracker
Medication Tracking

Choose who to share with
Harriet Clarke

Send Data

The user can select which features of the application they want to share with their specified user

Share Data

Select which data you want to share:

☑ Heart Rate Readings
☑ Blood Pressure Readings
☑ Mobility Tracker
☑ Medication Tracking

Choose who to share with
Harriet Clarke

Send Data

5.2: It is simple for the user to select the options they want to send to their specified user

Share Data

Select which data you want to share:

Harriet Clarke ●
Doctor Smith ○
Paul Clarke ○
Social Worker ○
Carer ○
Add a new user ○

2.4: The system must be linked to the user's family member's application. If the user adds their family member as a "User" they can share as much data as they would like with them

4.1: The interface must allow the user to share data with their specified health professional

Figure 49: Sharing of data

Once a user has been "added" to the application, they will be available on the drop-down list, so they can always be available to receive information from the patient.

← **User Profile** ≡

About you

About You
Username: Harriet Cl...
Date of Birth: 4/1/1995

Personalisation. App remembers user's details from when they created their account

☑Please keep this box selected if you are happy for us to monitor your movements

2.1: Asks user's permission to be monitored by the application
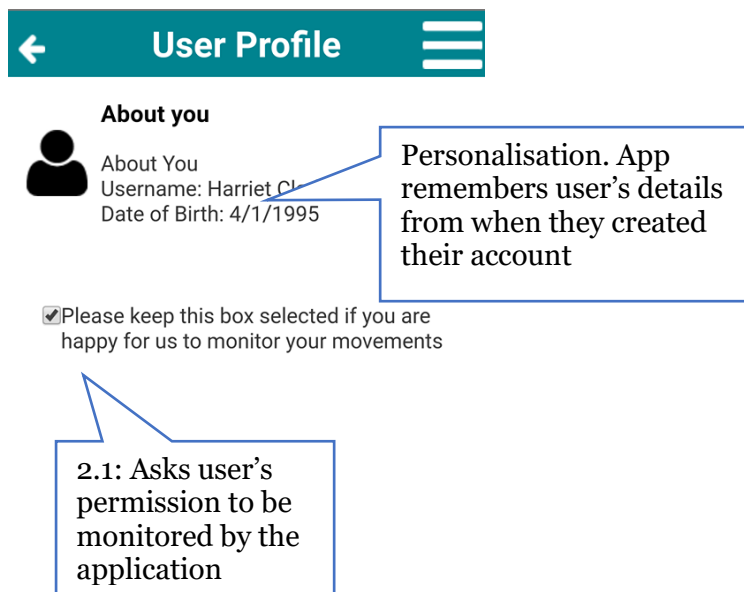
Figure 50: User Profile

The user profile allows the user to see the information that the app knows about them, as well as for the user to specify whether they are happy to be monitored by the application or not.

← **Settings** ≡

Choose text size:

ᴬ ᴬ A A A A

Choose a colour scheme:

Aa Aa Aa Aa
Aa Aa Aa Aa
Aa Aa Aa Aa

4.8: Allows for personalisation. Users can change the main body of text to the text size of their choice, which will remain every time the user logs in, unless changed

5.5: User can change the main colour scheme of the application, for the easiest viewing for themselves.
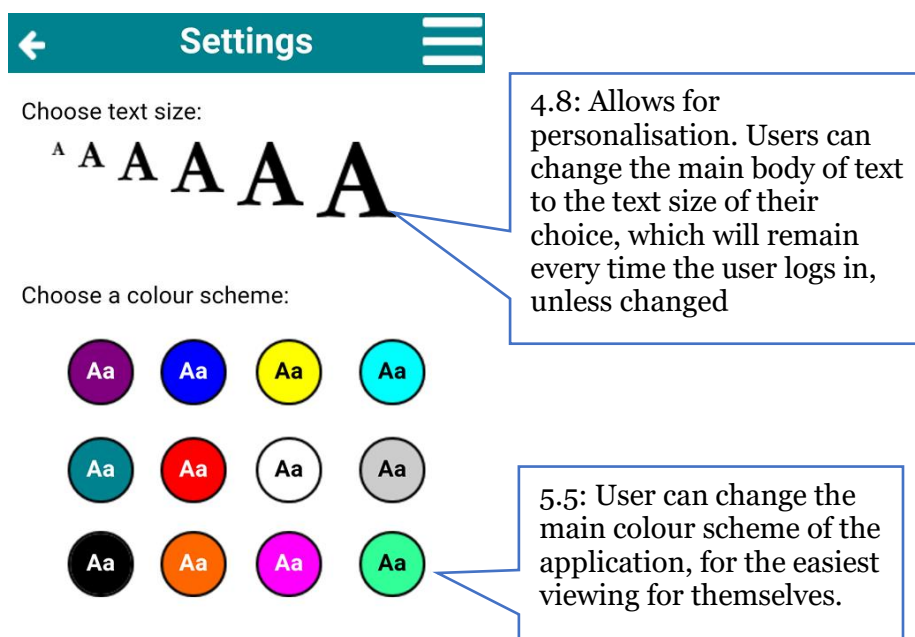
Figure 51: Settings

Based on the research found, it is important to give the users a choice of colours and sizes of texts. Some of our target audience will have impaired vision, therefore contrasting colours and large text may be very important features for them. For users will fine vision, they may just want a smaller text and to choose a colour which they find easiest to read.

Figure 52: Adding users

Adding of a user is very important, especially if the user has their mobility tracking turned on. This allows the family members to check on their loved one without having

to go to see them as often. The independence of the user is maintained, whilst their safety is preserved.

5.3 How the solution addresses the requirements

Below is a discussion as to how all the defined requirements have been met.

1. Medical Reminder requirements:
   1.1 The interface must display when a notification when the user has not taken their medication

If the user has requested for a reminder on a specific medication, they will receive a mobile notification at the time they requested. If they do not respond to this, dependent on the user's settings, the phone will notify them until they respond to the notification.

   1.2 The interface should have a list of medications for the user to choose from, as well as typing in their own

When the user attempts to add a new medication, once they have typed in the first three letters of the name of the medication, the system will then suggest names of known medications. This will help the user to navigate easier throughout the application, and correctly spell medication names.

   1.3 The interface should have images of the medications

When the user adds in a new medication, they can choose a colour and icon for their medication

   1.4 The interface must have a calendar feature

When the user selects a date and time, a calendar feature is used, rather than the user having to type in the date themselves.

   1.5 The interface must alert users to take their medicine at their specific chosen reminder time

If the user has requested for a reminder on a specific medication, they will receive a mobile notification at the time they requested.

   1.6 The interface should allow users to have refill reminders

This requirement has not been fulfilled in this first prototype. This is a future work implementation.

2. Mobility requirements:
   2.1 The interface must provide an option for user's permission to track user's mobility at all times

There is an option in the settings page, which allows users to select whether they want their mobility to be tracked or not.

   2.2 The interface must record the user's daily activity and be sensitive to movement around the house

When the user clicks on 'Mobility' on the Home Page, this shows how the users activity has been tracked throughout the day.

2.3 The interface could have an audio confirmation when the user has been active for their time necessary.

This could not be implemented into the prototype, due to limitations. However, this is a future implementation.

2.4 The system must be linked to the user's family member's application, to alert them of the user's activity if it is unusual

The user can add other users, and share information with them through the Settings page

3   Vital tracking requirements:

3.1 The interface must provide accurate measurement methods for vitals to be tracked

The Heart Rate measurer will provide accurate measurements for

3.2 The system must alert users if they are not correctly using the vital tracker

If the user takes their finger off the heart rate tracker whilst measuring, it will stop and the user will have to attempt it again.

3.3 The system could have auditory commentary on how to complete tasks

This is not currently implemented due to the limitations of the prototype.

4   General application requirements:

4.1 The interface must allow the user to share data with their specified health professional

In Settings, the user can add in users to allow them to share information. Here they can add their health professionals.

4.2 The application must adhere to the Data Protection Act

The users must create an account, and log in every time the use the app. Therefore, only they can see their data. It also has Terms and Conditions so the user knows their rights.

4.3 The system should provide a tutorial on how to use the application

This is not currently implemented due to time restrictions. This is a future work.

4.4 The system should be able to record and monitor measurements without an internet connection

Currently the prototype does not need any internet connection to work

4.5 The manufacturer of the application must inform users of the data they collect, and inform them of any potential privacy issues they may be concerned with

When the user creates an account, they have the option to read the Terms and Conditions, and must agree to them before using the application

4.6 The system should have a feature that allows users to track and view trends/history for all measurements collected

On the Mobility and the Vital Signs sections, there are Trends tabs available to see daily/weekly/monthly trends to track the measurements

4.7 The system must ensure reminders users have set up are always presented

Reminders will be shown at the time the user requests

4.8 The text size should be altered for the user's preference and settings should remain when the app is next re-opened

There is the prototype page in Settings that allows the user to change the size of the text on all pages of the app.

4.9 The interface won't have an exit feature

Due to the prototype this was not available to include.

4.10   The interface should provide guidance when the user requests it

There is a question mark icon on almost every page, for functions that may require assistance.

4.11   The system should allow users to log in to their account with authorised login credentials

User must log in with correct credentials to use the application.

4.12   The system could allow users to view their medical record history

This is not currently implemented. Further research and time would be necessary for this to be included.

5   <u>Non-Functional requirements:</u>
5.1 The interface should have large icons

Icons are large and easy to understand their function

5.2 The interface must be simple, easy to navigate and user-friendly

There are no multi-touch gesture functions – it is easy to navigate around as there are not many pages, and the back button takes you back to the previous page.

5.3 All icons should be self-explanatory and consistently placed within the system

All icons are representative of their function, and if repeated, are in the same place on every page.

5.4 The system must limit the usage of multi-touch gestures

There are no multi-touch gestures

5.5 The user should have the option to change the colour scheme in the application

In Settings, there is the option to change the colour scheme (12 choices)

      5.6 The system must be secure and encrypted

The user must log in with a username and password to view their account

      5.7 The system won't replace Carers/social workers

The user will still need carers – the application is just supplementary to their recovery

      5.8 The system should run error free

This is difficult to prove until fully implemented.

6. <u>Testing</u>

Due to the nature of the project, it is vital to test the prototype on the target audience. The app is going to be created for elderly users, therefore it is most important that they know how to use the application, and would find it useful and necessary in their day-to-day life. Therefore, the testing to be completed will be a think aloud test on several elderly people who fit into the target audience for the application.

6.1 User Testing – Think Aloud

Due to the nature of the application, the main user of the application will be the elderly patient. Therefore, it is necessary to test the functionality and usability of the prototype against real-life elderly patients. Due to the target audience, potentially not being as aware and understanding of technology, the testing has been limited to four tasks, and all three participants were asked to undertake and talk through what they are doing and thinking about when they are using the application.

The three users who participated:

User 1: Male, aged 79, recently had a hip operation

User 2: Female, aged 80, recently had two knee operations

User 3: Male, aged 76, has a wife with Parkinson's Disease

Due to the nature of the participants, they were not informed that it was a test, in case they felt like there was only one correct answer, and overwhelmed through the thought of being assessed. Therefore, when writing about the 'Think Aloud' section, answers will be written based on observations of the user's findings and the discussions has based on the completed tasks. The users were provided with the application on an Android smartphone, in which their screen activity and voice was being recorded during the testing process.
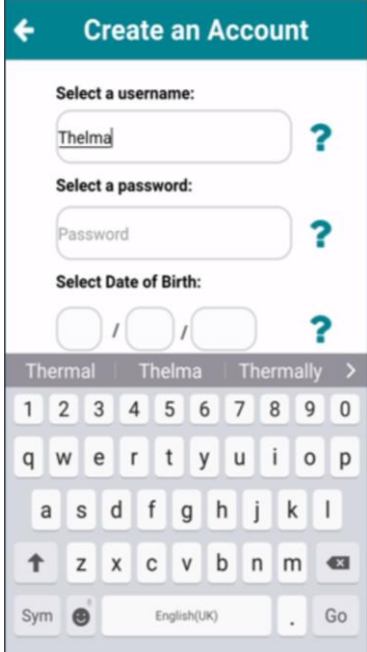
Test ID 1 – Create an account

Each user was asked to create an account using their name for the username and password.
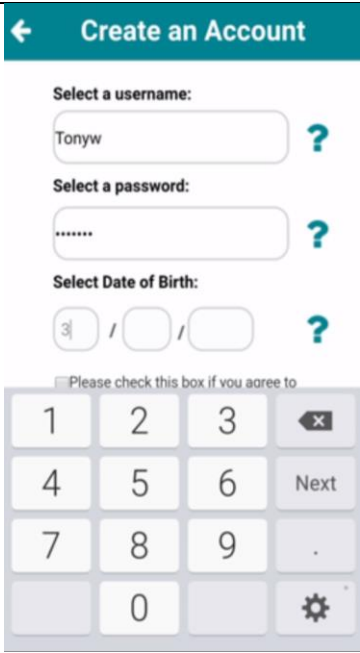
Preconditions: User has the application open on the start-up page				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
1	1	Made it clear he would like help when using the application. User was unsure as to whether he needed to click 'Register' or 'Log In' for a first-time user.	Was unaware that you could get the keyboard to pop-up by pressing the	Easy to select Found it difficult to type in name and password

			button on the screen.	
			Figure 53: User 1 struggling to enter in a username	
	2	User knew to select Submit to redirect to the Home Page	No problems found	Text size is good Easy to understand UI

Preconditions: User has the application open on the start-up page				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
2	**1**	User cannot locate where to start	User did not understand why she would need an account	
	2	User cannot find where to type in the username	User did not know how to locate the keyboard	
	3	User easily typed her name into the account username	No problems found	Easy to type in name, once the keyboard had been found
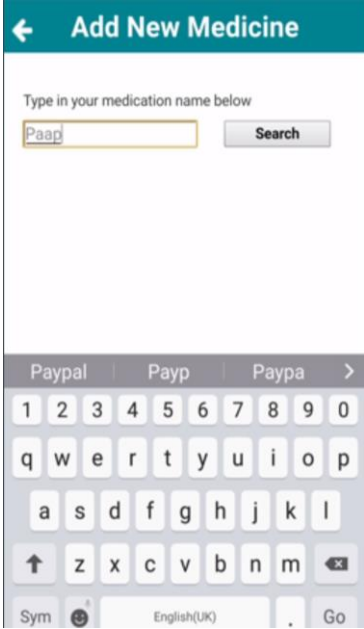
				Figure 54: User typed in username without any difficulties
	4	User knew to click submit to further onto the next page in the application	No problems found	

Preconditions: User has the application open on the start-up page				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
3	**1**	User knows to click on 'Register'	User thinks it would be important to allow users to log in with an email address	

	2	User easily knows how to enter in name and password	 *Figure 55: User easily knows how to enter name, password and DOB*	
	3	User knows how to enter in date of birth	User suggested the cursor moves to the next bar when entering in the date of birth. Usability of date of birth function is poor and difficult to type in the numbers	
	4	User knows to select submit to log in and be directed to the homepage		User likes the personalisation of the 'Welcome {name}' when they access the homepage for the first time.

Test ID 2 – Add a new medication: Paracetamol
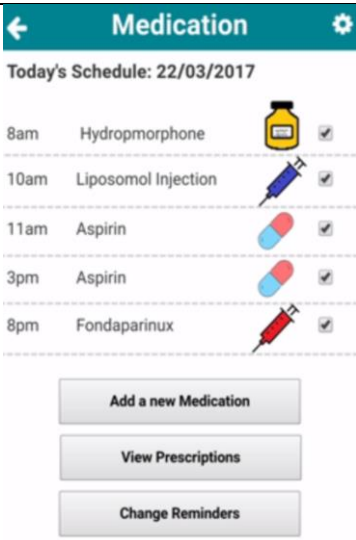
Preconditions: User is logged into an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
1	1	User clicks on Medication Tracking	No problems found	Easy to find where to select
	2	User clicks on Add new medication	No problems found	

	3	Typing in medication name	Didn't realise the textbox could be used to type in the medication Struggled to type in the name of the medicine *Figure 56: User struggling to enter in medication name*	
	4	Go back to home page	Arrow button is difficult to select	

Preconditions: User is logged into an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
2	1	User knew to select Medication Tracking	No problems found	
	2	User easily selected 'Add a new medication'	No problems found	User understands what the page is showing
	3	User knew where to type in the name of the medication	Found the box rather small to type in to	
	4	User unsure of how to get back to the homepage	Arrow is rather small and difficult to select	

Preconditions: User is logged into an authorised account

User	Step	Think Aloud	Problem Areas	Good Usability
3	1	User knows to select Medication Tracking	User suggests reminders for refills – reminds you a few days before they need to order more medication	
	2	User knows to tap the checkboxes when the user has taken the medication	User suggests a peripheral tick box for every week, so it is easy to view.	User likes the images of the medication
	3	User finds it easy to add in medication by selecting the button	No problems found	Figure 57: User can easily select checkboxes
	4	User types in medication easily	No problems found	User likes the idea of suggestions of medication popping up when the user begins to type in the name of the medication.

Test ID 3 – Measure your heart rate

Preconditions: User is logged in with an authorised account				
User	Step	Think Aloud	Problem Areas	Good Usability

1	1	User knew how to locate the area to track the heart rate	No problems found	
	2	User located easily the button to measure heart rate	No problems found	
	3	User presses finger down on heart rate until successful	No problems found	Thought it was easy to measure the heart rate. Success message was informative

Preconditions: User is logged in with an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
2	1	User easily knows to click on the Vital Signs button on the Home Page	No problems found	Icons are clear and easy to select
	2	User was unaware that you can measure your heart rate through your phone sensors.	It does not mention the user would need any external devices	
	3	User easily pressed finger on the sensor, and waited until it was successfully finished	Was unsure as to whether to take their finger off the sensor when it said, 'Success 100%'	User thought it was very easy to take the measurement.

Preconditions: User is logged in with an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
3	1	User knows to select Vital Signs	No problems found	
	2	User knows to select 'Click here to measure your heart rate'	User was unsure if you would need any external equipment	
	3	User keeps finger pressed until successfully measured	No problems found	User thought the feature of pressing the finger on the heart rate was very good and

				would be used by many.

Test ID 4 – Share data with Harriet Clarke

Preconditions: User is logged in with an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
1	1	User understood to click on the links for the checkboxes	No problems found	Checkboxes could be slightly larger
	2	User clicked on dropdown list to select the user they wanted to send it to	No problems found	User found dropdown list easy to use
	3	User clicked Share	No problems found	

Preconditions: User is logged in with an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
2	1	User knew to click 'Share'	No problems found	
	2	User knew they were checkboxes to select what to send	User thinks the checkboxes should be bigger	
	3	User knows to select user from the dropdown list	No problems found	User thought it was easy to select from the dropdown list

Preconditions: User is logged in with an authorised account				
User	**Step**	**Think Aloud**	**Problem Areas**	**Good Usability**
3	1	User knows to click 'Share'	No problems found	
	2	User knows to select checkboxes	No problems found	
	3	User thinking about how the information would be shared, and how the doctors would view the information	User wondering about the security and confidentiality features of the application	User found it easy to share the information

6.2 Options of design

After the think aloud testing, the users were asked to discuss the Home Page design, and choose features that they found preferable, and would like to see implemented into the application. Here are the results of this:

5 Welcome, John

Mobility	
Prescriptions	
Vital Signs	
Share	

Monday 20th April

Morning	Afternoon
8am: Ibuprofen	12pm: Trelstar
Evening	**Night**
5:10pm: Illetin 19:30pm: Ibuprofen	None Scheduled

6 Welcome, John

Mobility	
Prescriptions	
Vital Signs	
Share	

Monday 20th April

Morning	Afternoon
8am: Ibuprofen	12pm: Trelstar
Evening	**Night**
5:10pm: Illetin 19:30pm: Ibuprofen	None Scheduled

7 Welcome, John

Mobility	
Prescriptions	
Vital Signs	
Share	

Monday 20th April

Morning	Afternoon
8am: Ibuprofen	12pm: Trelstar
Evening	**Night**
5:10pm: Illetin 19:30pm: Ibuprofen	None Scheduled

8 Welcome, John

Mobility	
Prescriptions	
Vital Signs	
Share	

Monday 20th April

Morning	Afternoon
8am: Ibuprofen	12pm: Trelstar
Evening	**Night**
5:10pm: Illetin 19:30pm: Ibuprofen	None Scheduled

<u>User Responses</u>
User 1:

Preference is UI Number 1

↳ Likes the colours of the icons
↳ Likes the layout as it is obvious where to click
↳ Likes the contrasting colours
↳ Prefers the font than on UI Number 3

- He does not like the design options for 5-8, as he believes there is too much on the screen at once, and that the text in the 'Today's Medication' section is too small and difficult to read
- Does not like UI Number 2 due to the lack of colours
- Does not like UI Number 4 due to the dark background and light text – this is difficult to read

User 2:

Preference is UI Number 1

- Likes the contrasting, but finds it difficult to read white on dark colours, therefore does not like UI Number 3
- Finds the text easy to read (compared to Number 3)
- Prefers the colours and visual aspects – finds it difficult to understand what is going on in UI designs (5-8)

User 3

Preference is UI Number 1

- Likes the colours on Number 1
- Personally, prefers the visual aspect of Number 1, and thinks it will be easy to recognise better
- The images are better (compared to the designs on 5-8)
- Likes the look of Number 3, but doesn't seem the point of the "fancy" text.

Overall, the three respondents had very similar ideas when it came to the home page designs. They all preferred the current home page design (1), based on the colours, the layout and the ease of finding where to access options from. Therefore, from the feedback, it is clear that the best UI option is Number 1, which is already the prototype implemented. Therefore, no changes need to be made to the Home Page design.

6.3 Risk Assessment

Possible Risk	Risk Level	Likelihood of Event	Contingency Plan
Users are too apprehensive to use the app on their own	High	Likely	Ensure that there is a detailed, in-depth help page, and every page of the application has support to guide and encourage the user to use the application independently.
Many elderly people do not own smartphones (In 2004 only 17% of over 65's owned a smartphone [19])	Low	Somewhat Likely	You can now get smartphones from as low as £49.99. Therefore, the cost of the patient purchasing a smartphone would not be excessive, compared to other available options on the market currently.
Many elderly people do not keep their phones turned on throughout the day	Medium	Likely	During the training for the application, the user must be informed that to receive the notifications to remind them to take their medication, that they must keep their phone turned on at all times throughout the day.
User enters in incorrect information	High	Likely	There needs to be at least one Carer that still checks the patient has been taking the correct medications and is still looking after themselves correctly. This is especially important for the first few weeks as the patient is recovering. The application is not a replacement for a Carer, it is just a supplementary tool.
Heart rate measurements are not completely accurate	Medium	Somewhat Likely	Due to not having any external equipment, it is likely that the readings will not be 100% accurate. Therefore, the user should ensure that they do not rely on these measurements, they are just there for a guideline.

7. <u>Discussion and Conclusion</u>

7.1 Evaluation of the methodology

Overall, the prototype has received a positive reception from the target audience. There are changes to be made, and future developments that can be done, these are mentioned in the Future Work section. Due to the nature and the timescale of the project, the application could not be developed and programmed, however the usability and functionalities have been analysed and tested. Recommendations have been created based upon research and requirements gathering. These have deemed beneficial to the study, whilst attempting to understand which features are most important to the target audience. The difficulty of the application, is ensuring the elderly patients are fully aware of what the application does. Due to the elderly target audience, they have not grown up with mobile devices and technology, therefore tend to be more apprehensive and scared to use these sorts of devices. Therefore, ensuring an application of flawless usability and functionalities is vital. From the study, vigorous analysis through heuristic evaluations, functionality and usability testing of current applications, and soft systems methodology has been successful throughout. These methods have defined the project, and helped to create a solid prototype.

The questionnaire for medical professionals was well received. Receiving 18 responses from people within the medical field in the UK was successful – this number of responses was not to be expected. The questionnaire generally read well, and most of the questions were responded to well. However, there were some questions that in hindsight, could have been researched better and worded differently. These minor inequalities were picked out by some of the respondents. Overall, the questionnaire was a successful methodology to use, as it gathered a large response, and the ideas and responses from the medical professionals really helped to define the requirements. The questionnaire for the carers was not as well received. In hindsight, this was not necessary to do, however it did help to see various changes between the responses from the Carers and the Medical Professionals.

The heuristic evaluation and usability and functionality testing of the current applications, really helped to develop a set of requirements for the application. There were some features that helped by providing ideas of how these could be included in this application, but to be made more "user-friendly" for the target audience of elderly patients. The heuristic evaluation was very beneficial as it provided a different viewpoint for analysis. It ensured all aspects of the application were viewed and analysed.

Providing a Gap Analysis really helped to discover where the gaps are in current applications, which helped to provide recommendations to ensure these were provided in this prototype. The Gap Analysis was a unique analysis and really delved deep into the aspects of the application that could be changed. This helped to determine minimal details that are important to the user interface design, and usability of the application.

For the testing process, it was absolutely necessary that the users being tested, did not feel any pressure or intimidation when they were being assessed. Due to this, for the think aloud testing, the users were not made aware that they were being tested, they were just asked to do certain tasks and discuss what they were doing and what they liked or disliked about the prototype. The results from the testing were successful, however could have been more extensive. Due to the users not having any previous

experience with applications such as this, they did not have anything to compare them with. This resulted in the users not being as descriptive and constructive with how they would like the application to run. However, overall it was a great way to test out the application, and all three of the users seemed to view the application in a positive manner.

I feel that the title 'A Study in the use of Mobile Devices for Supporting the Care of Elderly Patients' has been fulfilled. I have used many methods to help measure the usability of appropriate applications. The entirety of the prototype is based upon how "usable" it is for an elderly user, who is not as competent as the regular adult using a smartphone.

7.2 Revised Soft Systems Methodology

As the project has progressed, the root definition and SSM model has changed. Therefore, it is important to update the SSM to ensure it is accurate with the finished product. When revising the previous SSM (found in 2.1 Soft Systems Methodology), it was clear that a new model should be created. The previous model represents how the project is planned and will develop. The new SSM Model describes the main aims and objectives of what the project has achieved.

CATWOE
Transformation & Customer: To provide elderly patients with independence of care at home

Weltanschauung: by providing appropriate access to resources that helps to monitor the health of the patient, through the use of mobility tracking that ensures the patient is active, reminders to take and refill medications, measuring vital signs, and the use of sharing medical information with whomever is assigned as the patient's primary Carer.

Actors: Doctors/Carers

Owner: NHS

Environmental Constraints: Usability of the application, budget constraints, safety of patient, confidentiality of medical records

Root Definition
"An NHS owned system operated by doctors and Carers to support elderly patients with independence of care at home, by providing appropriate access to resources that helps to monitor the health of the patient, through the use of mobility tracking that ensures the patient is active, reminders to take and refill medications, measuring vital signs, and the use of sharing medical information with whomever is assigne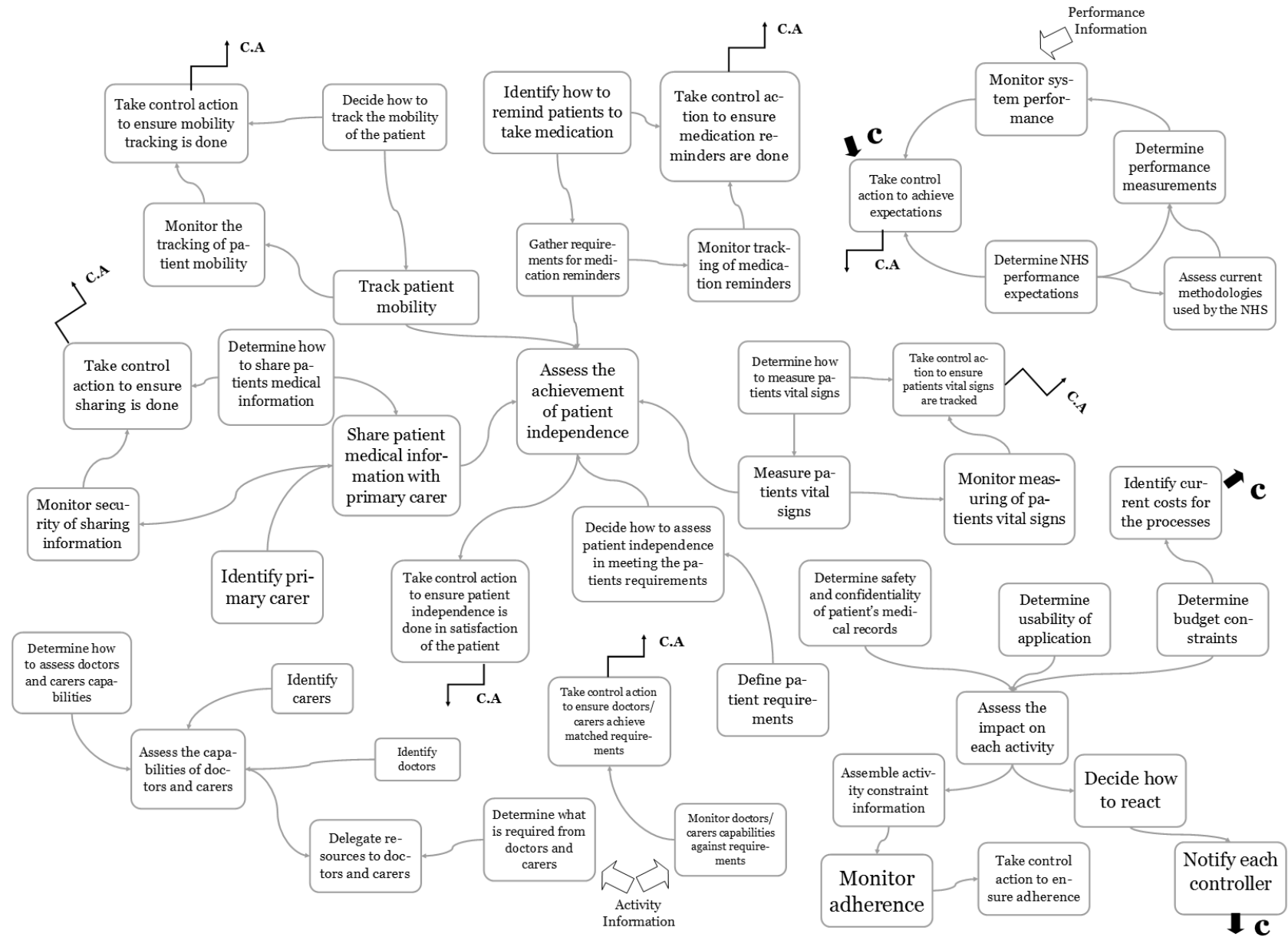d as the patients primary Carer, whilst considering the constraints in regard to usability, budget constraints and the safety and confidentiality of the patients data".

Revised Conceptual Model
This model has been approved by Doctor Wendy Ivins

Activity Assessment

An activity assessment has been provided to represent how the current methodologies and other technologies systems differ or coincide with the prototype created for this project.

Activity	How effectively is this done currently?	How is this addressed by the prototype?	How is this addressed by other systems?
Mobility tracking that ensures the patient is active	Physiotherapy is provided between day 1 and day 5 after the operation. Rehabilitation is regularly monitored by the physiotherapist. Home exercises are provided; however, these are not monitored.	The app will monitor the patients every move, and is even sensitive to movements such as unusual activity, and whether the patient has been inactive for several hours.	Withings, Fitbit and other fitness bands have activity trackers that provide users with a wristband that sends information to their phone of their activity for the day. These are effective but expensive. SHealth and other free mobile applications track mobility, however this is only if the user carries their phone with them
Remind patients to take and refill medications	This is currently not monitored, and is down to the patient to monitor themselves.	The app will allow patients to add in their medication with reminders for when to take them.	There are several free mobile applications that allow you to do this – such as Medisafe and Med Helper as previously mentioned.
Measuring patient vital signs	Carers and district nurses will take the patient's vital signs, depending on their needs. This is dependent on how often the Carer can visit the patient in their own home.	The app allows you to measure your heart rate through the sensors on the phone. It will also allow you to track your blood pressure and heart rate trends.	SHealth application currently allows you to monitor your heart rate and blood glucose through the application. However, it is not very accurate. More expensive options such as Withings Steel HR and Wireless Blood Pressure Monitor are easy to

			use and medically approved ways to measure vital signs.
Sharing of patient's medical information with whoever is assigned as the patient's primary Carer	On the day of discharge, the patient's assigned Carer will be provided with a copy of the care plan.	The app allows you to share any of the tracked information e.g. mobility, medication, vital signs to any assigned users email address.	You can currently purchase panic alarms that will alert users when the patient is in danger. However, other ways of sharing information to others is through apps such as SHealth, Medisafe and Med Helper. However, these apps do not carry all the features necessary, therefore it would involve the user having several apps to share data through, rather than one that shares all.
Provide appropriate resources that helps to monitor the health of the patient	Intermediate care can be provided to those who need extra support to help recover from an operation [20].	The app allows the users to view trends for their mobility and vital signs, to check they are recovering well. The alerts ensure the patient is continually monitoring their recovery period.	Withings has a Home security camera that tracks and detects noises and motions, as well as the ability to alert you when necessary. However, there is not a system that I currently know of to monitor and track the wellbeing of the patient in their own home [21].

7.3 Evaluation of the Output

The aim of the project was to focus on researching into technologies that help elderly patients measure their vitals, keep track of their mobility, and be reminded to take their medication. Due to this, an application prototype was created to allow users to tailor this to their medical needs. Overall I think the prototype was a success, as it was well received by the target audience throughout the think-aloud testing.

The prototype provides options for the users to track their mobility, medication and heart rate. These are effective and easy to use. The recommendations and requirements were vigorously analysed and chosen. As you can see, these have all been adhered to in the Prototype Design. The scenario originally described that the application would be a supplement for elderly patients who are recovering from an operation. The application would not be a replacement for a Carer, as based on research found, the individuals still need Carers to help them with physical aspects of their recovery, such as getting upstairs, or putting on clothes. Therefore, the application is only appropriate for certain tasks, and does not expect much interaction from the user.

As I have only created a prototype, and not the developed application, it has been difficult to fulfil all the necessary requirements. However, due to the author's capabilities, the timescale and the nature of the project, it was not necessary to create the application. I am happy with how the prototype has been created, and it received a warm response from the elderly users whom it was tested upon.

Overall, I feel that the prototype has been successful and the usability of applications for the elderly on mobile devices has well and truly been analysed effectively, using many different methodologies of assessment, which all helped to create the final output prototype.

7.4 Outlook on the future work

There are many ways in which this project could be taken further. The main way the project could progress would be through the development of the application, it's availability for the target audience to download on to their smartphones. There are many other future work developments, that were unable to be completed due to the short timescale of the project. These are listed below:

- Create a tutorial for the application, to ensure that users know exactly how to use the application when they first download it.
- Expand and gather a wider range of testers, to help gather a much wider and unbiased response from the target audience.
- Allow for personalisation and tailoring within the application – for example, if a user only needs to keep track of their medications, the other features would not be on the users home screen, as they are not relevant to their recovery.
- Create an application from the medical professional/carers perspective. This way, they can view many patients at one time, and see which ones need urgent attention, and easily view the patient's recovery period. In the long run, this would help relieve the stresses on the NHS services, which is a main aim of the project.

- Create an alternate design of the application, so that the user does not need very much interaction with the application at all. This would be a great way to help care for patients who are unable to use the application, such as those with Parkinson's Disease or Dementia.
- Explore ways in which the application could be interlinked with the patients' medical history and records, therefore when the user attends a doctor's appointment, their Doctor will be able to see how well the patient has been getting on every day.
- The application could be expanded and have more features available for tailoring, for example a physio section which ensures patients have done their daily exercises, and refill reminders for medication
- Link refills for medications to the local pharmacy. If the patient is immobile, this way the pharmacy will know to deliver new medication to the individual.
- Conduct further and more intensive user testing of the created application. This would be done using varied user scenarios, and a full heuristic evaluation could be undertaken.
- Ensure full training is implemented, and that the user would be safe in their homes, whilst understanding why the application is given to them.
- Identify any further privacy implications, and ensure these are defined and delivered before the application is used.

8. <u>Reflection</u>

Overall, I am happy with how this project has progressed, and what has been achieved. I have put in a lot of time and effort to the project, and regularly met with my supervisor. The project has helped me with my time management skills, especially due to the short timescale of the project. As I started the project, I struggled to know where to begin to initiate the project process. I wanted to start creating questionnaires and making the prototype, however I knew that before I did any of that, I had to do my research to ensure the project was relevant and appropriate for its audience. It was a struggle at the beginning, as I felt I was falling behind because my Initial Plan wasn't reflecting my current progress. However, after time, I realised that the research was very important. Despite what my Initial Plan suggested, I spent the first few weeks gathering research, understanding the problem, and the aim of the project. After this, all the aspects started coming together, and I started to gather further information from the target audience and medical professionals. I was very surprised at how much effort was required to create the questionnaire. The questions needed to be accurate and explicit, to ensure that respondents could fully understand what was being asked. This took longer than expected, however I am glad that I spent a lot of time on this, as the questionnaire was very informative and looked professional.

One aspect I struggled with was the Soft Systems Methodology. When I had done this previously, I had encountered several difficulties. I am very glad this project included SSM, because I had not fully understood its function until completing this work. From this experience, I feel like I have learnt a lot about SSM, and I would be sure to consider using it again in the future.

This project helped me to develop my personal skills, research skills and improved my approach to organisation. I have applied many tools to this project that I have learned throughout my degree, such as heuristic evaluations and SSM. These techniques have been very beneficial to the project. Another positive outcome of the project is that I learned many new techniques, such as state transition diagrams and gap analysis, which enabled me to enhance the quality of the content within the report.

8.1 Communication and Project Management Skills

Throughout the project, I have met with my supervisor weekly, as specified in the Initial Plan. These meetings were very beneficial to the project. The interaction and discussions had with the supervisor, helped to flourish and develop the project. I feel that the communication between myself and the supervisor was regular, and it was easy to share files through a shared Google Drive folder in which was set up.

Due to these discussions, I feel there are many skills that I could potentially take further in my career prospects. My communication skills in a one-to-one situation have definitely enhanced, which in turn has improved my confidence. I feel at the beginning of the project, I was not very confident in my knowledge and abilities, especially after taking a year out of education to go on placement.

The skills and knowledge passed on to me by my supervisor, and through learning myself has been very beneficial to the project, and I hope to be able to express my increased confidence and project management skills during the oral viva, and throughout the rest of my career.

References

[1] Nuffield Trust, "Pressure on NHS beds could risk patient safety, Nuffield Trust warns," 16 12 2016. [Online]. Available: https://www.nuffieldtrust.org.uk/news-item/pressure-on-nhs-beds-could-risk-patient-safety-nuffield-trust-warns. [Accessed 20 04 2017].

[2] D. Campbell, S. Morris and S. Marsh, "NHS faces 'humanitarian crisis' as demand rises, British Red Cross warns," The Guardian, 2017.

[3] Shropshire Star, "Bed blocking 'is now biggest healthcare issue in Shropshire'," Shropshire Star, 2017.

[4] BBC News, "Pressure on hospital beds 'not improved by extra money'," BBC News, 2017.

[5] N. Triggle, "10 charts that show why the NHS is in trouble," 8 February 2017. [Online]. Available: http://www.bbc.co.uk/news/health-38887694. [Accessed 16 February 2017].

[6] Cornwall Smart Homes, "Cornwall Smart Homes," 2012. [Online]. Available: http://www.cornwallsmarthomes.co.uk/. [Accessed 16 February 2017].

[7] GrandCare, GrandCare Systems, 2016. [Online]. Available: https://www.grandcare.com/. [Accessed 16 February 2017].

[8] ProSec, ProSec Integration, 2016. [Online]. Available: https://www.prosecalarm.com/wellness/. [Accessed 16 February 2017].

[9] Independa, Independa, Inc., [Online]. Available: http://www.independa.com/. [Accessed 16 February 2016].

[10
] B. Wilson, Soft Systems Methodology: Conceptual Model Building and its Contribution, Chichester; New York: John Wiley, 2001.

[11] Apple Store, "Med Helper – Pill Reminder and Medication Tracker," Earth Flare, Inc., 13 September 2015. [Online]. Available: https://itunes.apple.com/gb/app/med-helper-pill-reminder-and-medication-tracker/id438926478?mt=8. [Accessed 2017 April 11].

[12
] Apple Store, "Medisafe Pill Reminder, RX & Medicine Tracker," MediSafe Inc., 2017 April 07. [Online]. Available: https://itunes.apple.com/gb/app/medisafe-pill-reminder-rx-medicine-tracker/id573916946?mt=8. [Accessed 2017 April 11].

[13
] J. Nielsen and R. Molich, "Heuristic Evaluation of User Interfaces," CH1 '90 Proceedings, Copenhagen, 1990.

[14
] J. Nielsen, "10 Usability Heuristics for User Interface Design," Nielsen Norman Group, 1 January 1995. [Online]. Available: https://www.nngroup.com/articles/ten-usability-heuristics/. [Accessed 9 March 2017].

[15] J. Nielsen, "The Usability Engineering Lifecycle," in *Usability Engineering*, Boston, Academic Press, Inc., 1993, pp. 102-103.

[16] Samsung Electronics Co., Ltd. , "Samsung Health," Samsung Electronics Co., Ltd. , 10 April 2017. [Online]. Available: https://play.google.com/store/apps/details?id=com.sec.android.app.shealth&hl=en_GB. [Accessed 11 April 2017].

[17] National Institute on Deafness and Other Communication Disorders, "Hearing Loss and Older Adults," NIDCD Information Clearinghouse, 2017.

[18] Axure, "DESIGN THE RIGHT SOLUTION," Axure Software Solutions, Inc., 2002-2016. [Online]. Available: https://www.axure.com/. [Accessed 11 April 2017].

[19] Ofcom, "Adults' media use and attitudes," Ofcom, 2015.

[20] NHS UK, "Your care after discharge from hospital," 15 01 2015. [Online]. Available: http://www.nhs.uk/Conditions/social-care-and-support-guide/Pages/hospital-discharge-care.aspx. [Accessed 10 04 2017].

[21] Withings, "Withings: Home," Nokia, [Online]. Available: https://www.withings.com/uk/en/products/home. [Accessed 10 04 2017].