Ambient Assisted Living for the Elderly using Website Applications

By Gurvir Dhillon

Project Unit: PJE40 - Engineering Project
Supervisor: Dr Athanasios Paraskelidis

Abstract

This project aims to give an overview of ambient assisted living and how it can benefit the ageing population, with software that provides them with an easy user interface to log daily activities. The project explores industrial solutions with the various applications it provides. There will be further mention of the design process, how this had an overall impact on the development and a critical analysis of the artefact during the testing stage.

I would like to thank Athanasios Paraskelidis, my supervisor who supported, advised and guided me throughout my third year project. I would also like to thank all my friends and family who motivated me throughout this project. More specifically, my mother Avinash Dhillon whose positivity uplifted me to believe in myself through a very difficult year.

Chapter 1 - Introduction

1.1 Problem Description

As medical researchers continue to make medical evolutions, the average life expectancy of the elderly has increased in parallel. This increase in life expectancy has led to an increase in the cost of healthcare and receiving treatment due to high demand(Romback, D. 2014, June 2). Ambient assisted living(AAL) is a type of digital assistance which aims to provide support to those living in isolation - in particular the elderly and vulnerable. AAL devices are known to be very expensive as the hardware required can often be costly - which can lead to less accessibility for the general public due to potential financial constraints amongst consumers. AAL has provided an improvement in the quality of life for the elderly and those with disabilities by allowing them to live independently. Smart home technologies in particular have shown its potential benefits in preventing health problems that could otherwise cause a higher risk of hospitalisation and long-term healthcare.

The elderly have a tendency to use less software technology for day-to-day living therefore industries consequently refer to hardware solutions to support these users. The purpose of this study is to provide support to the elderly using software solutions to support them with daily living. AAL systems must be implemented with security and privacy which is of utmost importance for the user and has been proven to be a challenge within the field itself, as these systems have been well known for collecting data from its users and their living environments (surroundings). The system created was designed to be adaptable on many different devices, therefore interoperability played a crucial role in the development of the artefact. It also had to be reliable for its user as user experience is a vital aspect in the usage of a system.

1.2 Project Aims

The overall project aim was to provide an interface suitable for elderly users to communicate essential information to the application to help them cope with their routined activities such as taking medication and reminding them of daily events. The system will be of low cost and must provide a user friendly interface which will adhere to the w3c standards for accessibility.

1.3 Project Objectives

- To conduct a literature review which gave insights into AAL technologies that have been developed.
    - This was also beneficial for improving the artefact, avoiding issues in the solution that was developed based on previous works and will allow for a better understanding of the field overall.

- Using a list of the chosen functionalities(features) by the users, a list of prioritisation of these features will be decided based on the responses and how important it is for the application overall.
- Design a user interface that has an array of accessibility features suitable for the selected target audience.
- Develop a software application prototype which provides AAL with low cost and a user friendly interface.

1.4 Project Constraints

- The system would be limited in terms of the amount of data that can be gathered regarding the user from the application.
    - For user testing the researcher asked the participant to enter fake data. Examples were also provided to avoid thinking time affecting their result.
    - Once the data was provided it was deleted immediately and only the result of their feedback was recorded.
- Hardware compatibility - financial constraints limited the hardware in stock.
- The application would be limited to the data that can be collected via the hardware. For example, the Fitbit can only gather information that is offered via the access token. For example, calories, step count, floors etc.
    - However, the application will not allow for fall detection monitoring as the Fitbit charge 4 does not offer this capability but later models offer this such as the Fitbit Versa 4.
        - Funding for later versions was denied therefore it could not be tested on the app.
- API usage
    - As the Twilio API was not brought, it was used on a trial basis causing strains on the number of system uses, how long the API can be used and the functionality provided.

Project complexity:

The artefact had presented challenges as there are numerous guidelines which needed to be followed such as the internet standards including the w3c. The system had to be accessible for users with a variety of accessibility tools available for the user to utilise. The system had to be user-centric with many tests being carried out regarding the functionality and intuitiveness of the user interface.

Assumptions:

- The target audience has a familiarity with using website applications previously.
- Users will typically access the device on a mobile or tablet device.

Chapter 2

Literature Review

Literature Review Elicitation Strategy

To gather the literature the data was elicited via google scholar, specifically gathering large amounts of data to begin with and then narrowing the scope down to make the text concise whilst providing as much information as possible. For each search, certain themes, keywords and topics were identified and searched for as part of the research.

As the literature review was conducted, requirements were conducted by potential clients which had helped identify common themes.

Search	**Sources**	**Number of results**	**Reason for search**	**Result description**
"Ambient assisted living"	Google scholar	302,000	This was the initial search as this formed the baseline of the knowledge gained from the completion of this project.	There was a wide range of literature surrounding the challenges with many proposed solutions spanding from hardware to software solutions. From this search there was further understanding of what AAL was and the impact it has on society.
"Software ambient assisted living"	Google scholar	107,000	The decision for splitting the results amongst hardware and software had been made as background knowledge on previous software solutions was needed before working on the artefact.	Too broad, many results were related to healthcare settings of AAL and the elderly did not directly use the software.
"Ambient assisted living security"	Google scholar	59,300	The decision was made to look at the previous security of other applications in order to avoid previous criticisms or any issues that may appear affecting the application safety.	Articles have a common theme of IOT. Mostly related to authenticating users to such systems.

"Ambient assisted living fall detection"	Google scholar	57,700	A common theme when searching for ambient assisted living had an aspect of fall detection. Therefore, the fall detection was explored in more detail to gain more of an understanding of what are the current solutions to the use of fall detection.	Gained loads of results, many themes of the same researcher, this had then led to more search keywords.
"Ambient assisted living usability"	Google scholar	28,900	The elderly must have a user friendly interface due to the standards that are enforced over the web.	Various literature reviews on previous solutions.
"Ambient assisted living cost"	Google scholar/ Google	166,000	AAL devices have various costs, therefore further research was conducted to analyse the proposed costs, as well as the cost effectiveness of the proposed solutions.	Further research outside google scholar was conducted for more information as the sources on google scholar was limited.
"Ambient assisted living IOT"	Google scholar	24,700	Many proposed solutions consisted of IOT devices therefore research was conducted to see other examples of IoT AAL devices.	Large amounts of data gathered related to cloud systems.
"Ambient assisted living fitbit API"	Google scholar	911	Different solutions were searched to see if it narrows the search so more information can be synthesised.	Specific to a Fitbit device, all proposed improving living for the elderly.
"Mobile ambient assisted living fitbit api"	Google scholar	895	This was to shorten the number of searches that did not consist of mobile applications.	Mobile device solutions appeared with its various connecting hardware devices. This usually consisted of the next of kin being able to monitor the elderly using their phone with non-intrusive methodologies.
"Software ambient assisted living fitbit api"	Google scholar	868	Gave an overview of the different types of devices that could use the fitbit API for AAL.	More general devices (could consist of laptop, IOT, tablet, wall mounted device etc)

Introduction:

As the general population ages more research is being conducted into AAL. This helps monitor the ageing and vulnerable population using unobtrusive technologies such as mobile technologies, smart devices and a range of medical sensors (Romback 2014). This literature review aims to provide an overview of the current research into ambient assisted technologies including the current trends in AAL technology, the themes alongside any gaps within current research and its future direction.

Background/History of AAL

There are currently 3 generations of AAL. The earliest form of AAL dates back to 1992 where devices would traditionally consist of an alarm button used in emergency situations, for example a fall or change in symptoms. This would then alert a pre-programmed contact linked to the device. This gave users a sense of safety, as well as providing reassurance to family members and caregivers. The use of this technology was limited if the subject was unconscious or unable to trigger the alarm (Blackman et al 2016).

The second generation of AAL technology created a way to prevent accidents by monitoring hazards without human intervention (Blackman et al 2016). This targeted a wider audience compared to the first generation, as those with cognitive disabilities could also make use of such a system. This design was criticised by researchers describing it as intrusive to the users privacy.

The third generation of AAL had built upon the previous version but was improved as it had responded to the change in environment in an unobtrusive manner - meaning that the devices would be disguised as everyday objects. These technologies had aimed to reduce the social implications compared to the previous generations, such as reducing the embarrassment of using cognitive supportive devices (Blackman et al 2016). This reduces the feeling of self-consciousness for the end-user - allowing the user to have a better user experience. The third generation of AAL had also integrated artificial intelligence (AI) to help adjust to the users needs and their preferences.

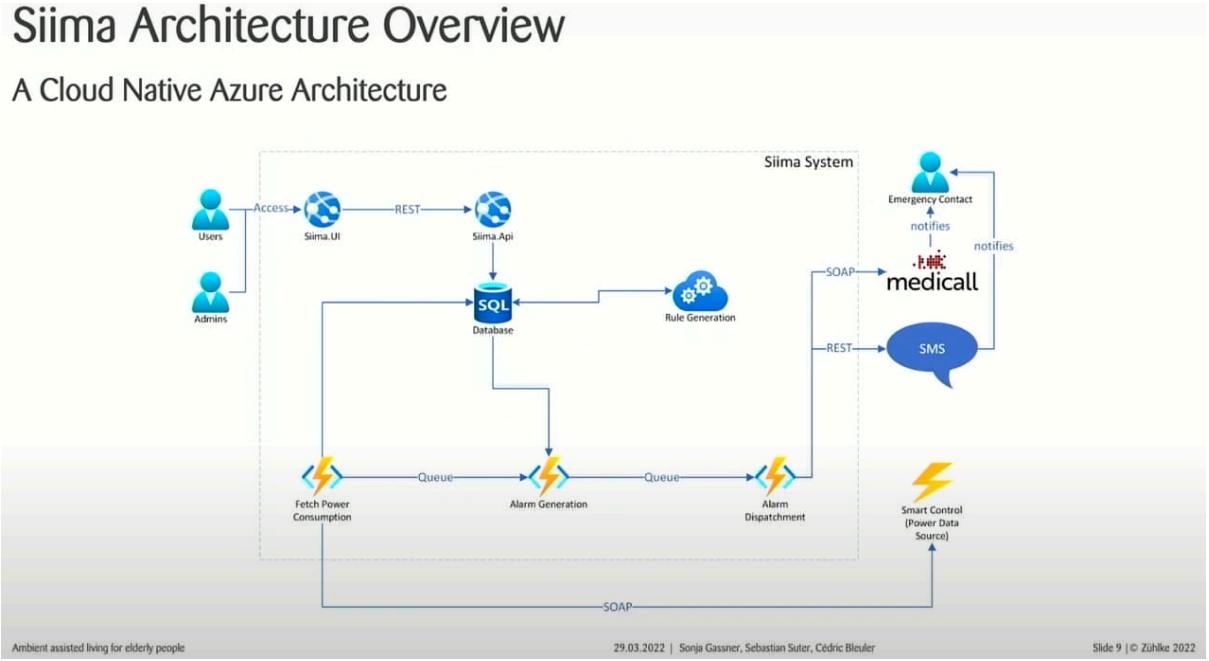
Current Solutions

There are many proposed solutions for AAL which aim to improve the safety and quality of life within the elderly. These solutions tend to involve using either wearable technology, sensors, smart home technology or software applications.

One example of AAL currently in use is medication management applications. As the elderly ages, research demonstrates that 85% have at least 1 health condition and 65% as having at least 2 health conditions (Parra et al 2016); this may possibly indicate medication would also be required to help deal with their symptoms or illnesses. However as the elderly experience cognitive decline, a medication management application can help them to better manage their daily intake (Ganesan and Gowda et al 2019). Researchers have also expanded this functionality, applying it to areas such as meal intakes.

An example of a medication management application in real use with wide availability would be “Pill Reminder Pro”, which is described as a multifunctional system allowing the user to create reminders for medication intake for any time frame (Licea 2014). The application also allows individuals to track the amount of medication the user currently has, to alert them when a refill is required. This application allows for elderly users to better manage their medication habits as well as being alerted with enough time to refill their prescribed medication.

Furthermore, smart home automation is another solution to AAL which helps the elderly manage their conditions such as limited mobility. Smart home automation makes tasks such as adjusting the temperature or other household appliances that can be controlled, easier as it can be managed remotely (Rashidi, P. & Mihailidis, A. 2012). Moreover, other smart tools have used various health monitoring tools such as smart technologies analysing biological samples, after a user has completed their personal hygiene routine, measuring sleep patterns using the mattress based on their sleep cycle, breathing, movements and many other methodologies. This has all been designed to improve the wellbeing of the user and to track their overall health. This has been further developed by researchers using power consumption levels in the users homes and machine learning algorithms to track their users daily activities. If the user has not completed a task within the normal time frame of their daily routine, such as “putting the kettle to boil” or “the user turning the television on”, an alert is sent to their carer to check up on the user. This has been integrated in everyday objects as users are being tracked via their energy consumption level. This provides users with privacy as there are no uses of cameras, microphones or any other device that can be seen as intrusive (Gassner & Suter et al 2022). The diagram down below shows the overall methodology for how such a system works.



[Figure 2.1 - system architecture]

(Gassner & Suter et al 2022)

The system used an API to collate any data of the user and their power consumption throughout the day. This would store the appropriate data in an SQL database and based on the data gathered, it would check the rule generation (the previous data) and determine whether further intervention was required. If there was a change within the “normal timeline” of power consumption, a message was then sent to the emergency contact via SMS.

Similar to the previous solution mentioned, other solutions such as environmental hazard detectors were invented as a safety mechanism for users. Contributors had created a way to detect hazards such as gas leaks, floods or potential fires to prevent the likelihood of an incident. Once discovered, it informed either a caregiver or the emergency service depending on the given situation or its programming. This device was built to protect the elderly from developing dangers and potentially save lives (Al-Shaqri & Mourshed et al 2016). This could however be criticised, due to its obtrusive methods of gathering data and the proposed solutions requiring the use of cameras/detectors, causing privacy concerns for its users. Consequently this could potentially lead to a reduction in the chances of user acceptance for the device.

During the Coronavirus pandemic, technology was developed to combat loneliness and isolation in the elderly. According to research, over half a million elderly people did not receive human interaction for at least five or six days a week (Pattison 2020). In an effort to reduce loneliness, devices such as the amazon echo were introduced to allow video conferencing family members by voice activation and features that provide the user with entertainment (such as watching the news or their favourite tv shows).

Some systems offer RFID tags for daily activity. The author indicated that there are many forms of recording data which in turn can allow for machine learning algorithms to understand user habits. The RFID had been used to recognise patterns of the users behaviour in order to understand what task is being completed by the user, for example making tea. The system requires object detection, activity recognition and interference recognition (Philipose et al 2004). This was used to try and gain an understanding of the users behaviour and what their daily activities included.

Fall Detection

Fall detection plays a critical role in AAL and has been a very popular area of research within the field. With studies showing that falls are the number one leading cause of injuries and admissions to accidents and emergencies within hospitals (Ganesan B et al 2019). AAL systems have responded by using wearable technologies which respond to a change within the environment (in the form of latitude and longitude of the user) and if a change has occurred, it sends a notification to the caregiver or next of kin. There are many forms of detection including the use of sensors in the form of accelerometer and pressure sensors. But most notably a smartphone fall detection which consists of four nodes from the chest, waist, wrist and ankles - this would send all the data to the next of kins smartphone (Ganesan B et al 2019). The nodes would send data of any changes to indicate if a fall has occurred. This concept has allowed researchers to apply this concept to other areas, including machine learning where they can implement heart rate monitors as an additional parameter to measure the health of the user for further confirmation. This has a high

prevalence within the field, as the elderly have a higher risk of accident related injuries and thus hospital admissions, however the accuracy of sensor detection would be considered very crucial to the client as well as the financial cost that may incur with the use of this product. Furthermore, in a domestic household this may have limited use unless the nodes are made easy to wear for the user for extended periods of time.

Cost

The cost of AAL devices varies depending on its functionality. Fall detection would be more expensive to build compared to a medication monitoring application due to the increased use of hardware and its high level of complexity. AAL devices offer more features and capabilities tend to be more expensive.

Cost of devices such as fall detection which are offered through the use of smartwatch or pendant usually require a monthly subscription. Experts analysed that “the best fall detection systems” (Olson & Lindberg 2023) incurred an annual subscription of $330.

Cheaper alternatives are usually in the form of software applications as it requires no use of physical hardware. Medication management software such as Medisafe Pill Reminder are free to download on the app store. However this application contained costs supporting in-app purchases that range from $2.99 to $39.99 (Medisafe n.d). This included additional features such as adding an unlimited amount of medication.

Voice activated assistants, depending on its features, can cost between $30 to $200. The high end Sonos One included smart home integration as it provided users with entertainment, as well as allowing for smart home integration features where it can control other smart devices with auditory simulation. For example, the user can instruct the Sonos One to turn on the thermostat (if it is also a smart device that is interoperable) and if configured correctly will turn on. The Apple HomePod Mini which costs $100 still provides the user with voice control but also allows communication between different Apple homepod mini’s such as sending voice messages to other homepod devices - this assists users to communicate with others easier if they have the same device in another home setting. The Apple HomePod mini also provides end-to-end encryption that ensures the voice data is securely kept.

Product	**Estimated cost (cost in US dollars)**
Fall detection	$330
Medisafe pill reminder application	$2.99 - $39.99
Voice activated assistant	$30 - $200

Security

There is a hidden trade-off between the perceived advantages (safety for the elderly and vulnerable) and its perceived barriers (privacy and data security). Research shows that

general attitudes from the target users feel as if they lack privacy by having such systems within their homes (Heek, J. et al 2017, July). Although AAL technology is dual compatible in many different environments namely nursing homes and hospitals - it is still under utilised due to the issue of privacy in private housing environments.

The Mirai Botnet was an insecure IoT device which was utilised in many AAL devices in the form of smart technologies (they had used items such as cameras and thermostats), the attackers had accessed these devices in order to launch a wide scale DDoS attack on the internet which left many AAL devices not functioning properly. This resulted in 600,000 victims being affected. As this was used in many AAL devices, it generated a sense of distrust among users having to use smart technology, in particular the elderly. This created an issue for those who relied on receiving the appropriate care via smart technology. For example users would not be able to receive information such as prevention from incidents such as a gas leak, if the device was used in fall detectors this had caused the users to not being able to alarm carers or authorities if they had hurt themselves.

Privacy

Commercial ambient assisted living products identify and understand the ethical concerns regarding the sales of these products which have led to companies such as UbiCare (which were an AAL prototype that was under development in 2015) not utilising cameras and microphones as this is commonly perceived as ways of violating their privacy instead they have utilise sensors that can be embedded into furniture. This is to reduce the reluctance of acceptance from the user(Dasios & Gavalas et al 2015).

In the field of AAL there is an ongoing issue of establishing a secure connection between medical devices and its remote hosts that can access the information. AAL systems are known to rely on a collection of data from the user to provide them with better care. This raises privacy concerns for the user. To counteract this, the argument is made to use proxy-based authentication. This would be suitable for IoT devices to prevent potential security breaches (Porambage & Braeken et al 2015).

Conclusion

To conclude, the emergence of AAL has alleviated pressure on health services and has drastically improved the quality of care in all aspects of life for the elderly that live in isolation using technologies that have evolved over many years. An area that must be addressed in AAL is the issue of privacy and security. AAL devices gather and transmit data passively. This also brings in ethical considerations and if doing so is more beneficial to the user or making the user feel under constant “surveillance”. However, some argue that as users are buying an AAL device they are automatically consenting for data to be gathered passively.

Chapter 3

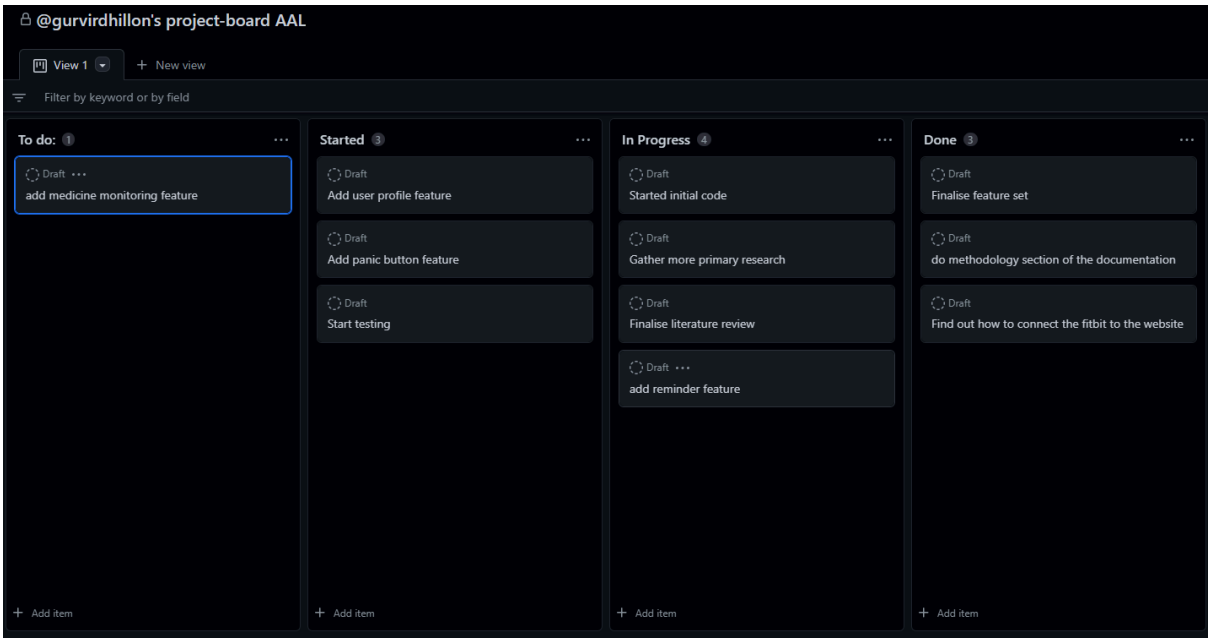
Methodology

Whilst there were many methodologies to consider, after conducting large amounts of research, the choice of narrowing down the scope of potential development strategies was made.
These included the following development strategies:

- Agile Kanban
- Iterative development
- Incremental development
- Waterfall methodology

Kanban

Kanban is a methodology which emphasises the use of continuous delivery and involves the constant need for adaptation depending on the customers' requirements. It consists of using the kanban board which showcases visual representations for the flow of project development. The stages of the work are divided into columns. It divides the columns into progression points and each section represents different stages of workflow. This creates an improvement in the efficiency of work throughput and allows for a better overview of the project. GitHub has also adapted this methodology creating their own GitHub Kanban project board using this same principle, managing programmers and their workload(Github Docs n.d). This has been used in the github repository to help track features and the status of the current workflow.



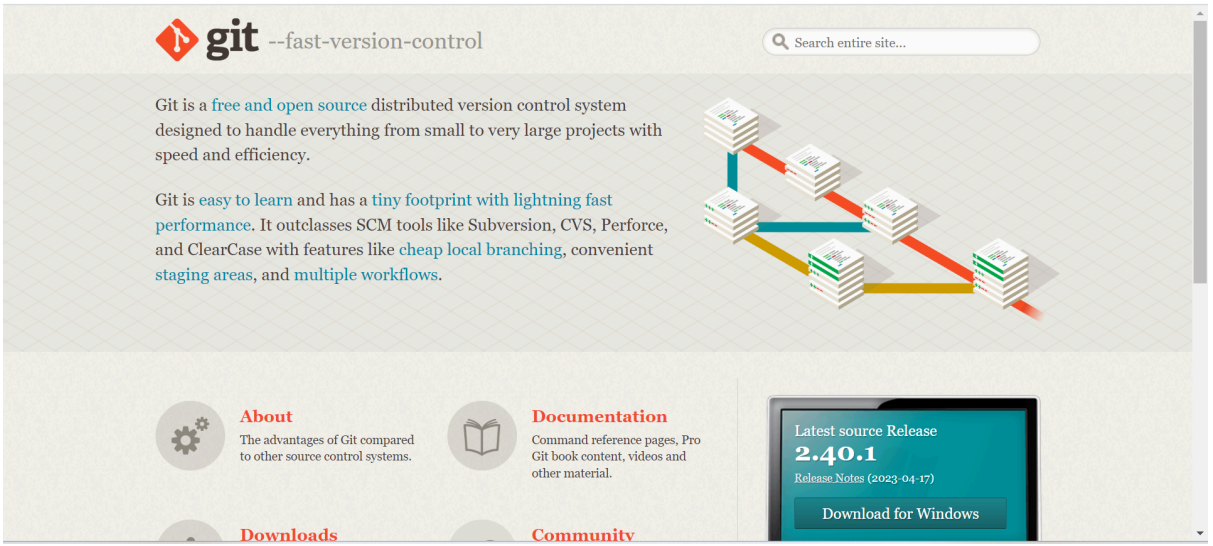
[Figure 3.1 - Kanban board]

Kanban would be beneficial to the project as the intended audience have changes made within the requirements, therefore flexibility will be needed and adaptation will be essential. The use of kanban will also reduce the risk of project failure as the target audience is constantly communicated with, in comparison to other methodologies, namely waterfall (Anderson 2010). The use of kanban increases organisation in the software development life cycle, as well as increasing the level of efficiency by limiting the work-in-progress to a manageable amount. Kanban provides tools which help maintain continuous improvement by being able to gain insight into the tasks at hand.

Iterative Development

The iterative approach involves breaking down the project into smaller segments called iterations (Larman 2004), with each iteration entailing continuous delivery. Similar to kanban, it offers greater flexibility and adaptability to the requirements changes. There is a higher quality of product satisfaction produced by using the iterative approach as a rapport is built with potential users. However this approach can often lack an accurate timeline due to the number of iterations being unpredictable, which can lead to an increase in further work required past the project submission.

This approach would fit well within the project, as there is a constant requirement for customer feedback and this approach has many tools which helps manage the project including version control systems such as Git. This allows tracking of the code and its history. This will also help for continuous integration by using git branches. The branches can be merged and pushed out to the main (master) branch to ensure continuous delivery is followed.



[Figure 3.2 - Git version control]

Waterfall

The waterfall development process consists of 5 key phases: requirements elicitation, designing of the system, the implementation of the system, testing the systems functionality/usability and evaluating the built artefact. These phases must be completed in the specified order provided, with each phase building upon the previous phase (Royce 1970). This method allows for greater reliability of estimations on project timelines but it has also been criticised for the lack of flexibility it offers (Wysocki 2010). Once a phase is considered complete, there are no official reflections that are made therefore errors cannot be amended, henceforth it can often lack quality control in comparison to agile methodologies.

This methodology was discarded due to its inability to integrate new ideas after the requirements phase had reached its completion (Eason 2016), as using this methodology could potentially lead to customer dissatisfaction. Customer communication played a crucial role, as gaining feedback from stakeholders played an essential part and requirements can change overtime, therefore the ability to be flexible is required. Furthermore, as Royce has stated, following the waterfall methodology is less efficient as it requires the previous step to be completed prior to moving onto another phase.

Incremental Development

This involves the process of breaking down the development into smaller parts called increments. Each increment involves the idea of designing, eliciting requirements, developing and testing until its deployment. It has been complimented for its swift development process for software implementation. However, it increases the complexity as new requirements are consistently added (Larman & Basili 2003).

Agile methodologies such as the incremental development approach, reduces the risk of project failure as the target audience is considered throughout the development and their requirements are collated throughout the development process. The requirements for the project will have many complexities which will require heavy planning before its execution.

Development Approach Chosen

The choice of using a hybrid iterative and kanban approach was made as the tools for both will heavily profit the development of the artefact. Github kanban allows for better tracking of the entire process whilst also ensuring the workload is manageable. This has also allowed other features such as issues to be converted from the kanban board which has also been utilised in the development. The iterative approach works well in parallel as there will be continuous movement on the project board between the project status of a given feature set. Furthermore, the iterative approach offers tools such as git which will allow for version control and checking previous iterations of the project. Continuous development and integration plays a crucial role in both approaches, therefore this will be adapted to suit the project.

Chapter 4

Requirements

Initial Requirements Elicitation

The original requirement strategy was to conduct interviews with elderly users, however due to limited sampling this was not viable.

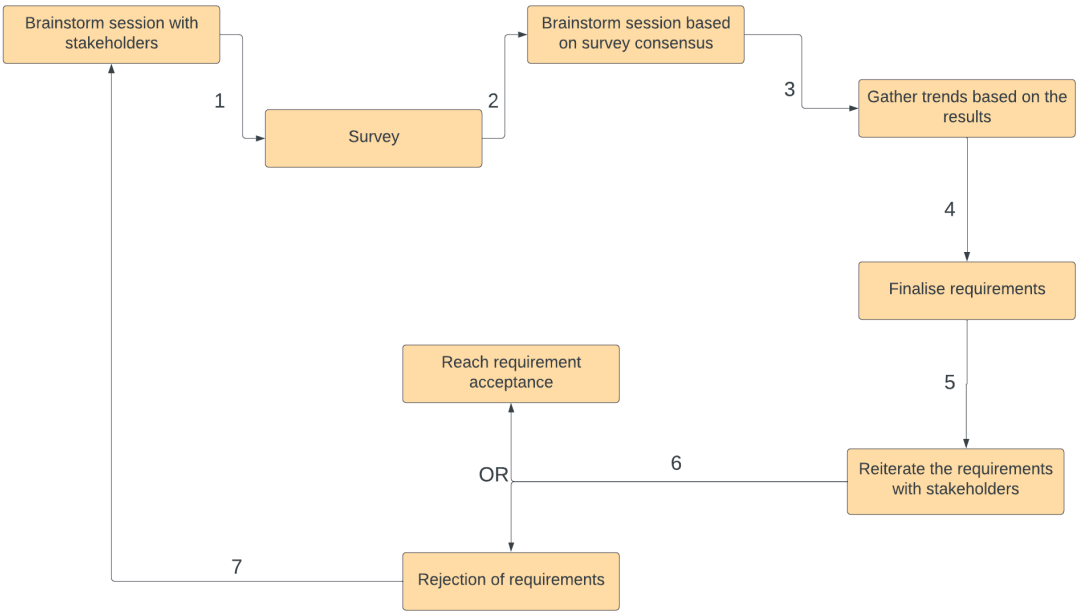
Therefore, an alternative method which combines the use of brainstorming with a smaller group of elderly users (stakeholders) and conducting surveys based on the responses provided by the users during the brainstorming session. The choice was made for using both requirements strategies to gain a holistic understanding of the system that was to be created. This is because other stakeholders such as family members and next of kins can also voice their opinions on the creation of the artefact.

Survey

The survey was split into 2 separate parts - the first part focused on functional requirements whilst the second, targeted the prioritisation of which feature is seen as the most important.

The survey gathered 18 responses which is not generalisable to the general population, however due to a low volume of responses to the survey this was not possible.

Requirement process



[Figure 4.1 - Requirements process]

The figure shows the elicitation process whereby the survey and brainstorm sessions were consistently compared and trends were identified from the data which would form the requirements that would be presented back to the stakeholders.

Iteration 1 - using the brainstorm, surveying and gathering trends

As can be seen by the table provided below, this was a brainstorming session with a potential client on what may help them with their day-to-day activities. The brainstorming session was mainly focused on gathering functional requirements and feature implementations. The requirements follow the iterative approach as the process is repeated until perfected. The following table was created through consumer feedback from various stakeholders.

Feature idea	How to implement it?	MoSCoW prioritisation	Justification
Smartwatch monitoring users pulse	The API communicates with the iPad. The iPad gets info back to the user via a notification.	Must	This idea had stemmed from the third generation of AAL devices which had focused on integrating embedded technologies in the form of everyday items (such as a pendant) but allowing for the elderly to communicate their needs accordingly (Blackman et al 2016).
Medicine monitoring	API to send out notifications, based on the time.	Must	As the elderly age devices such as medication reminders would be useful to allow for constant reminders for when a medication should be consumed.
A panic button	Can press a panic button on the smartwatch/the tablet event listener triggered and goes to	Must	The first generation of AAL had introduced an alarm that could be summoned when a user requires medical attention (Blackman et al 2016).

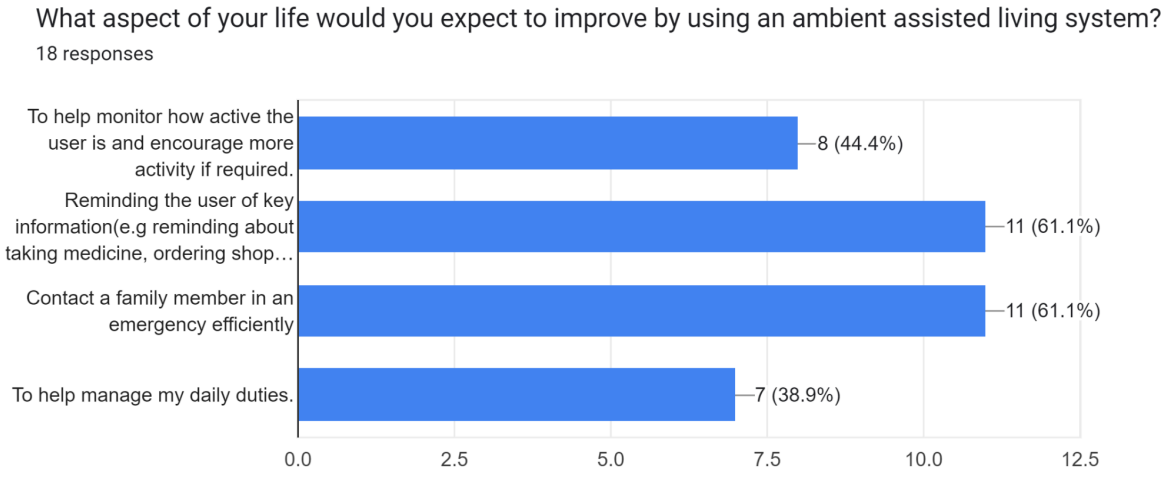
	next of kin		This was also considered very important to the client for staying in close contact with family members.
Reminders	API to a reminder app/calendar	Should	This has been considered a “should” as the elderly can use this however, other applications may also help with this therefore this is not top priority.
Blind motion detector	API which connects the motion detector to the tablet device.	Could	Due to high complexity, this requirement solely depends on the amount of time that is left during the project as its configuration may be of high complexity.
User profile	A profile stores data about the user.	MUST	This is a very popular feature amongst the application as it provides a more catered for experience to its users.
Prompting App	Gets data based on local time, user input may be required on what they like to do throughout the day and notifications are fed through to the user based on the input.	Should	Prompting is a should because it would require high complexity and may require the use of machine learning. This is achievable however the data may not be configurable for the elderly user as they may not know how to inform the device on their daily routine.
Contents gathering feature - entertainment	Plays favourite family photos, gets access to favourite music, puts on free source TV etc... this helps deal with loneliness	Could	This is a “could” as it would require external use of entertainment and is not essential for maintenance of their vital health.
A virtual assistant	A bot that responds to the user, maybe an API that talks to them as if they were an actual user.	Would	This would require too much complexity therefore is out of scope for this project.
Smartwatch monitoring falls	API communicates the velocity of the user (using data from the triaxial accelerometer) recorded to the app and feeds it back to the app - the app then sends notifications to caregivers on a fall.	Could	This depends on the smartwatch as some watches are able to detect falls from the data it collects.
An app that recommends safe exercises to the user based on their condition	Web scraping from the internet - “safe to do activities” for the elderly users or those with specific information.	Should	
Default message	This will either be an extension plugin or this can be done via SMS.	Must	This helps the user to send default messages such as “call me” as the elderly may find difficulty to type text messages.

The brainstorm session had influenced the questions asked within the questionnaire. This was to confirm if the data collected from the brainstorming sessions was representative of what the users would like to see within the application. This was also to narrow down the requirements that should be focused on specifically for a more representative group of users/stakeholders.

The researcher had chosen to create four main categories for defining the requirements

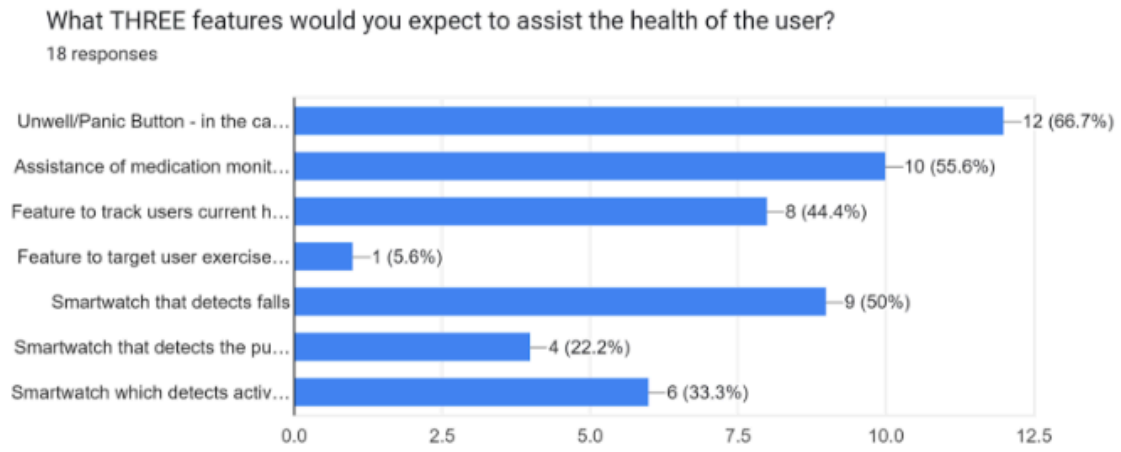
- Functional requirement = FR
- Non functional requirement = NFR
- Interface requirement = UI
- Accessibility requirement = ACR

Accessibility and user interface are crucial components in the development of this project in terms of usability, which can contribute to the overall usage and popularity of the application. Even though non-functional requirements are the umbrella term for accessibility and interface requirements, due to its huge amounts of sub-requirements the choice of breaking these requirements into its own 2 sections was made. Splitting the accessibility into its own section would allow for easier monitoring of which standards are being abided by and which standards must be implemented as well as providing better organisation to the requirements overall.



[Figure 4.2 - AAL improvement device preferences]

61% of users who responded had considered emergency communication and reminders as the most important feature for the application.

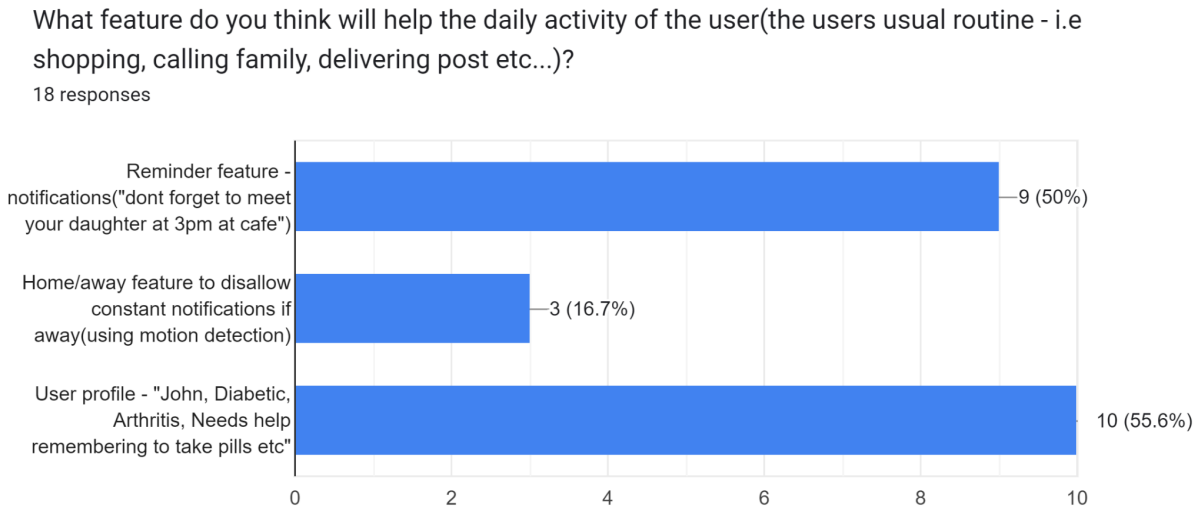


[Figure 4.3 - feature improvement preferences]

The statistics have further shown clear indication that contacting a family in an emergency promptly and efficiently, is a very big priority for the stakeholders therefore this will be considered heavily when creating the application. This has been backed by the statistics which have seen 12 individuals classifying this as a feature they expect to see in the health-led application.

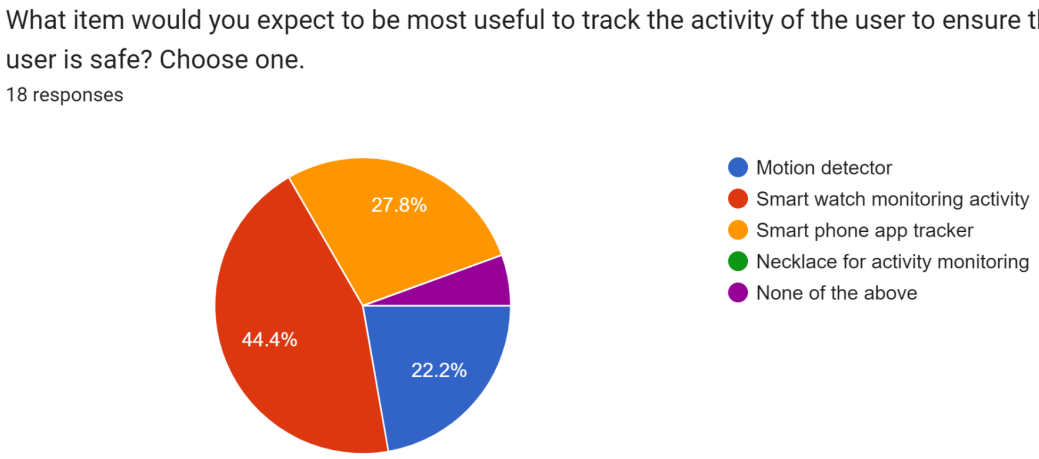
The two most important features according to the results were the medication monitoring management application and the panic button. These will be features of high prioritisation and importance as they are expected from the target audience.

The next question addressed was to improve the target audience user experience in general.



[Figure 4.4 - daily activity feature poll]s

The results showed strong support for the user profile feature. This was closely tied with the reminder feature.

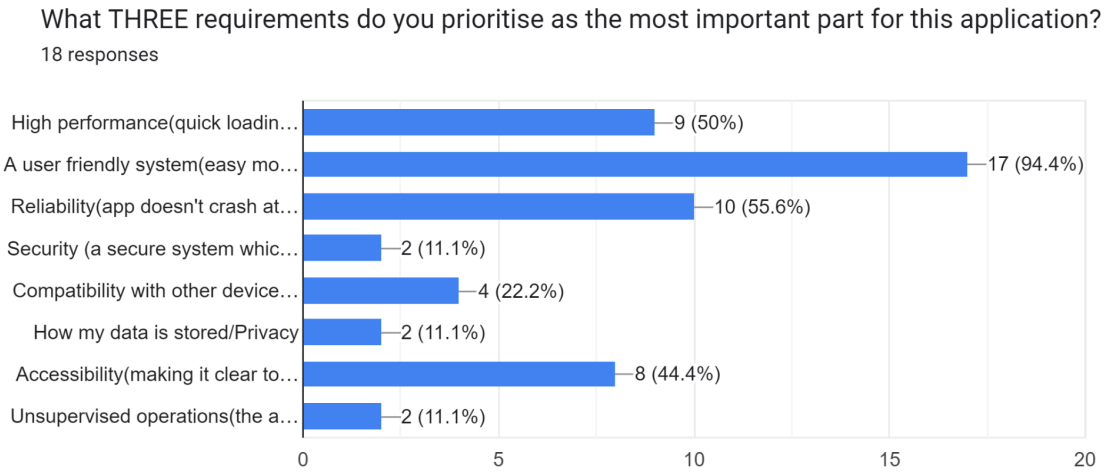


[Figure 4.5 - product preference]

Prior to creating the survey, motion detection was the initial idea which would be used alongside the creation of the application. However, due to a strong preference for the smartwatch feature this will be considered the priority.

Survey information about the non functional requirements

The researcher asked for the users preference for which non-functional requirements they feel are most important when using an application. This is crucial as the development process and testing process will account for these requirements and will iterate over the improvements when necessary.



[Figure 4.6 - non functional requirements]

The above had confirmed a friendly user interface to be a very crucial requirement when creating the app with 94.4% responses.

Functional requirements

Identifier	Description	Justification	Priority
Reminder Feature (FR001)	This feature allows the elderly user to remember events and helps them to plan in advance.	As the elderly age, they undergo cognitive decline(Park, H. L., O'Connell, J. E. et al 2003).	Must
Chat feature(FR002)	It has been reported that elderly individuals are more likely to suffer social isolation which can possibly increase chances of depressive symptoms. The system should cater for the elderly facing social withdrawal by providing an interface where they can communicate with others.	(Pattison 2020)	Could
Panic Button Activation(FR003)	In the nascent era of AAL, a panic button was one of the few ways for the elderly to communicate if they were in trouble. The application will use the same principle to communicate to their next of kin if they require assistance.		Must
Fitbit tracker compatibility(FR004)	The application will allow the user to pair their fitbit device which will receive data from the individual and place it onto the application.		Should
Medication reminder(FR005)	This feature takes the information provided by the user about medication that they are taking and reminds them to take it at a certain time.		Should

Non functional requirements:

Identifier	Description	Justification	Priority
User friendly interface(NFR001)	From the survey, 94.4% of users classified a user friendly interface as their most important part of an application.	Therefore this will be at the forefront of development when creating the artefact. Following W3C guidelines will also be needed.	Must
Reliability(NFR002)	Reliability was the second most popular response in the survey with 55% responses saying this was		Should

	very important for the application.		
High performance(NFR003)	Users tend to find it extremely frustrating when a website is slow therefore the system must be able to handle response in a very pacey manner.		Could
System security(NFR004)	System security is also essential. As the backend database will be SQLite, there must be a heavy consideration for potential SQL injection and reducing the risk of this.		Should
Accessibility(NFR005)	Accessibility guidelines will be followed and adhered to - the researcher will follow the guidelines based on WCAG and w3.org.		Must

UI requirements

Identifier	Description	Justification	Priority
Easy to correct mistakes(UI001)	As the target demographic is elderly people, the system must make it simple for users to correct their mistakes and enable them to go back when required without needing great assistance.	This is important due to Nielsen's Heuristics(Nielsen 2005).	Must
Good error prevention mechanisms(UI002)	The system should prevent errors that may frequently happen. Continuously test the system is important and using participants to see if any mistakes may frequently occur during the testing stage so this can be worked on in the development iteration and can be reduced.	(Nielsen 2005). Error prevention mechanisms will be put in place in the settings menu where the user will be made to type to confirm if they would like to access the settings menu before taking them to the page.	Should
Minimalistic design(UI003)	The system should hide as much complexity as possible and should show a simple design which does not overwhelm the user.	(Nielsen 2005)	Should
Visibility of system status(UI004)	The system should provide the user with information that will help the user understand what is currently ongoing with the system. For example, the reminders should inform the user if they are up to date	(Nielsen 2005)	Could

	when all the content is loaded.		

Accessibility requirements

Identifier	Description	Justification	Priority
High contrast (ACR001)	According to research from w3.org guidelines, they have a contrast standard that must be met which will be considered when designing the system.	Web Content Accessibility Guidelines Working Group. (2008). Understanding WCAG 2.0: Section on Visual Audio Contrast Contrast. World Wide Web Consortium (W3C). Retrieved from https://www.w3.org/TR/UNDERSTANDING-WCAG20/visual-audio-contrast-contrast.html	Must
Large text and bold fonts for users (ACR002)	This is to help the elderly visualise information that is to be represented.		Must
Microphone accessibility (ACR003)	According to WCAG there are many forms of disabilities one of which includes physical impairments which limits the mobility of the user. The use of a microphone will allow the user to communicate with the software and gain the necessary information possible.		Should
Allowing navigation without use of a mouse(ACR004)	Some users may not have access to a mouse or may not be able to use a touch screen device. This may limit their interaction with the device. User should be able to access the application without mouse navigation.		Should
Text to speech(ACR005)	Using a web-kit, the user will click on a button and an event listener will read the text to the user	Eggert, E., & Zahra, S. A. (2019, October 4). *How to meet WCAG (quick reference)*. How to Meet WCAG (Quickref Reference). Retrieved from https://www.w3.org/WAI/WCAG21/quickref/	Could

The table above shows the finalised requirements. The iteration had presented an evolution of the initial to the finalised requirements via the requirements process.

The requirements had allowed the researcher to gather an idea of what features should be implemented to the application. This would be included within the design chapter where it will showcase the iterations of the UI based on client feedback and the different aspects of design that will be considered.

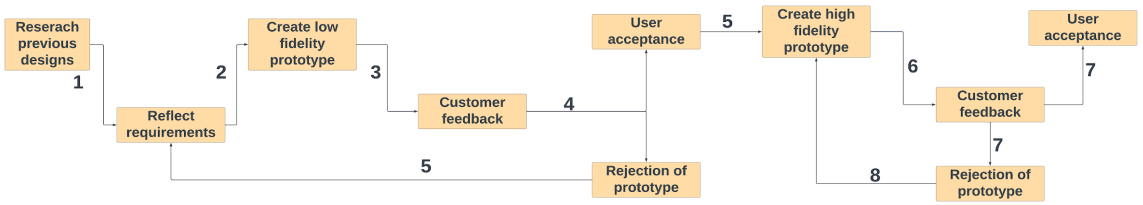
Chapter 5

Design

Introduction:

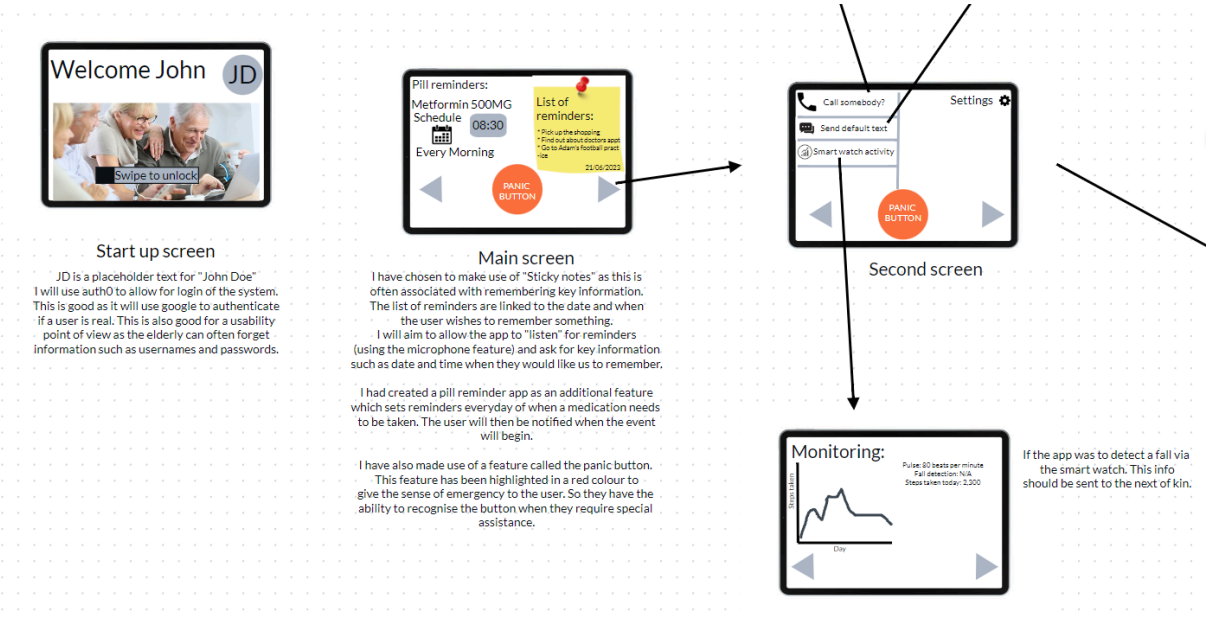
This section will address the design choices made throughout the process. As stated earlier in previous sections, the development methodology chosen involved the iterative approach throughout. The requirements section was used to address the behaviour functionality of the software. This section will reflect the user interface, the features that will be implemented and the process that was undertaken to determine this.

Design Process:



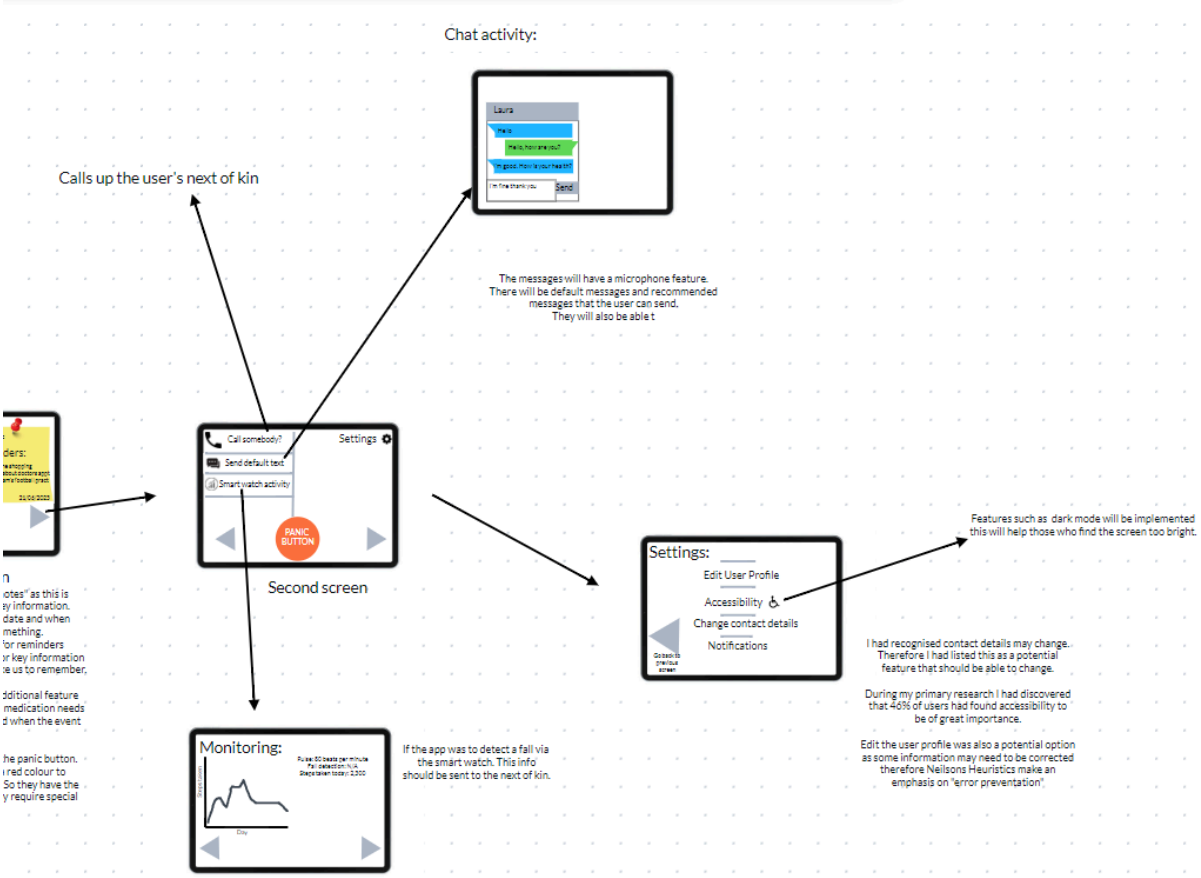
[Figure 5.1 - design process]

Iteration 1 User Interface Design:



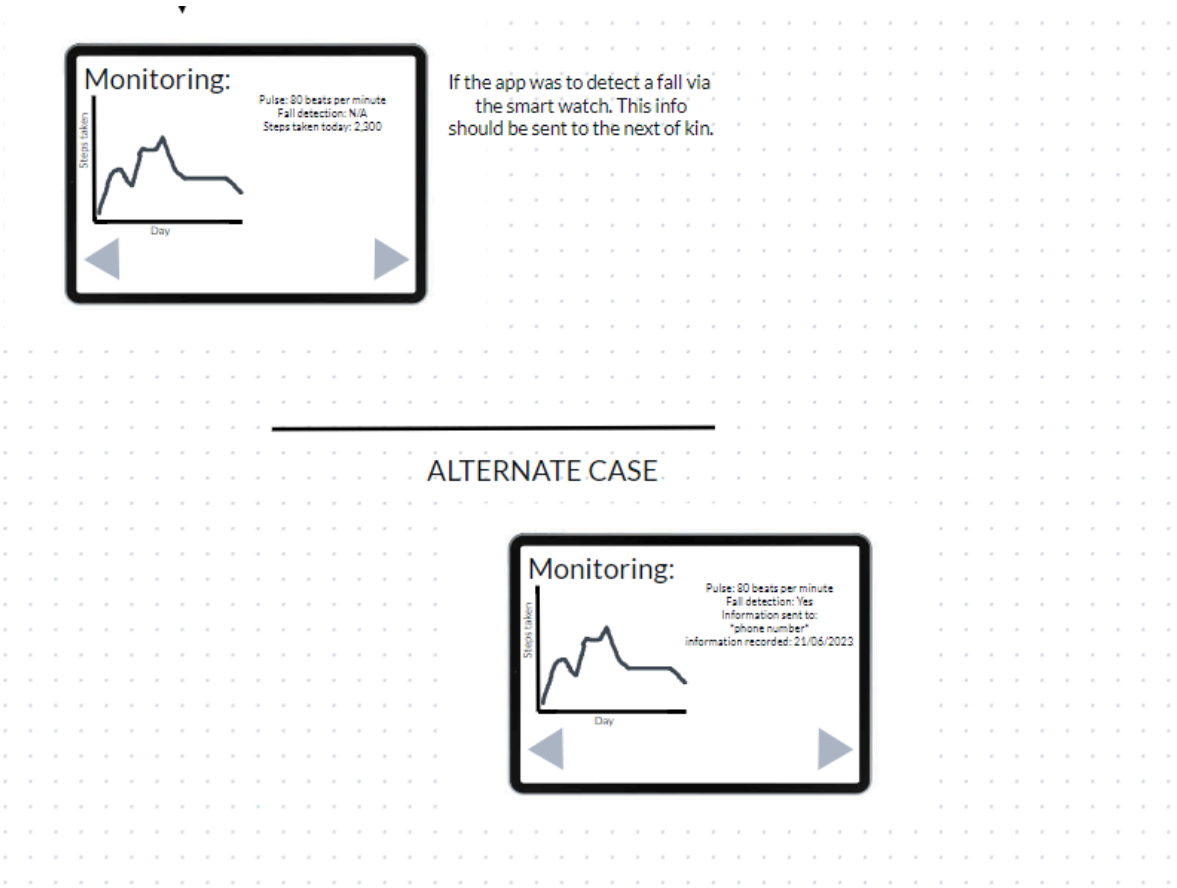
[Figure 5.2 - Iteration 1 UI design]

This was the first design which displays the start up screen, the main screen (which includes their medication notifications and their list of event reminders), the second screen which includes a button to call the next of kin, a chat prompt button and the section which generates the smart watch activity.



[figure 5.3 - UI extension]

This shows what the second screen extends to when pressing the button.



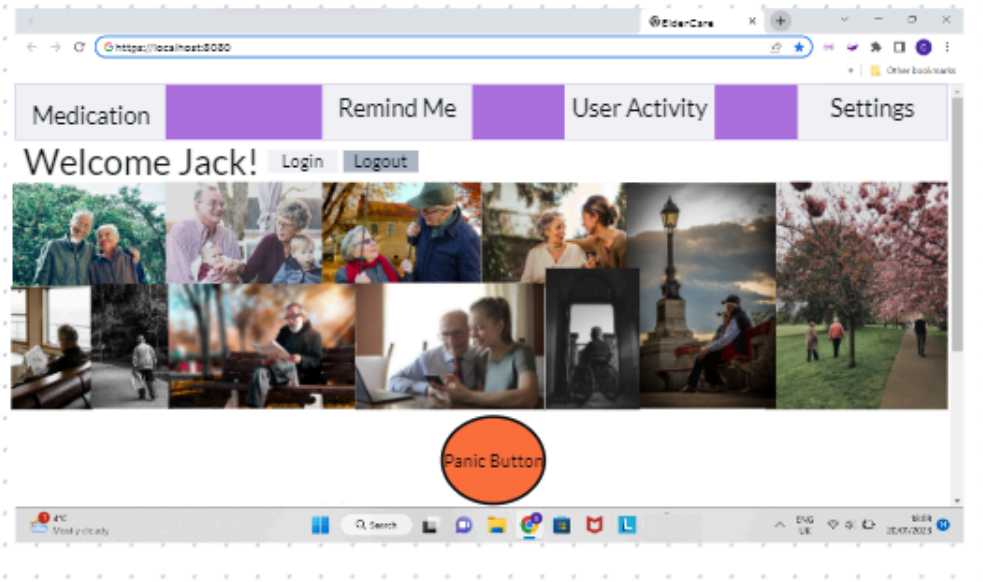
[figure 5.4 - activity monitoring iteration 1]

The feedback:

- Colour scheme to be improved
- The graph can be hard to read for the elderly
- Have an easier to follow navigation bar(looking at internet standards)
- The scroll bar may be hard to navigate for the elderly (as they may not be familiar with this format).

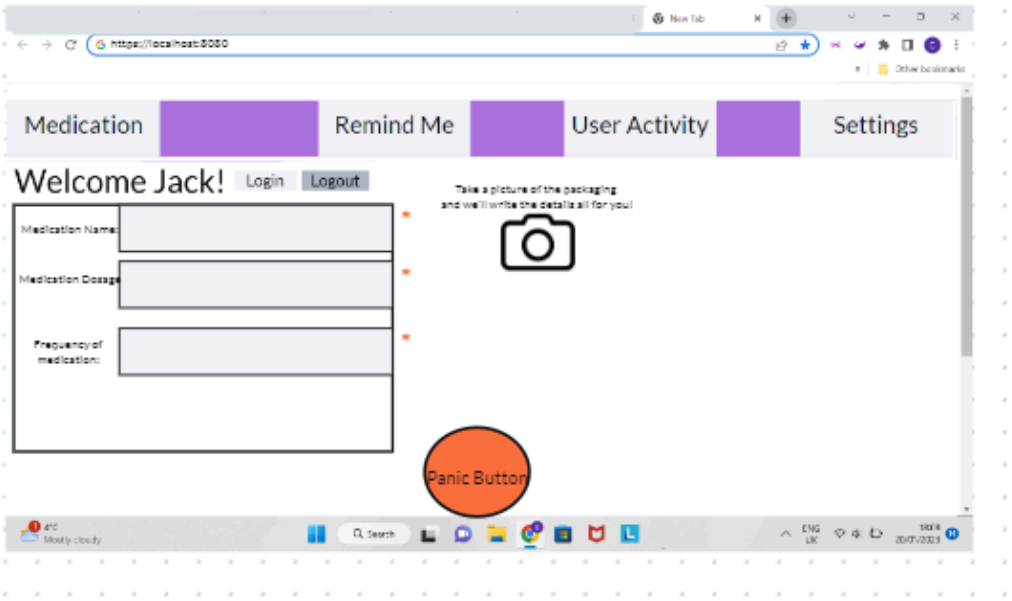
Following on from iteration 1, the feedback provided by the target audience will be used to develop iteration 2.

Iteration 2 User Interface Design:

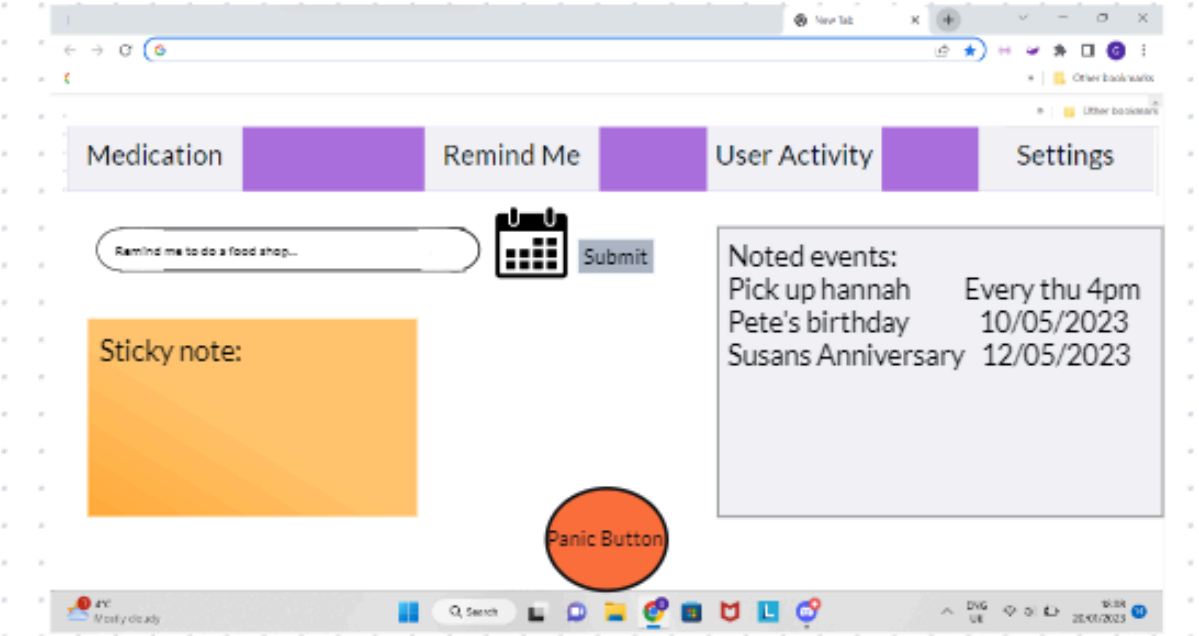


[Figure 5.5 - Homepage iteration 2]

This shows the home page of the application; it was designed with pictures to make it look visually appealing to its users when opening the application.

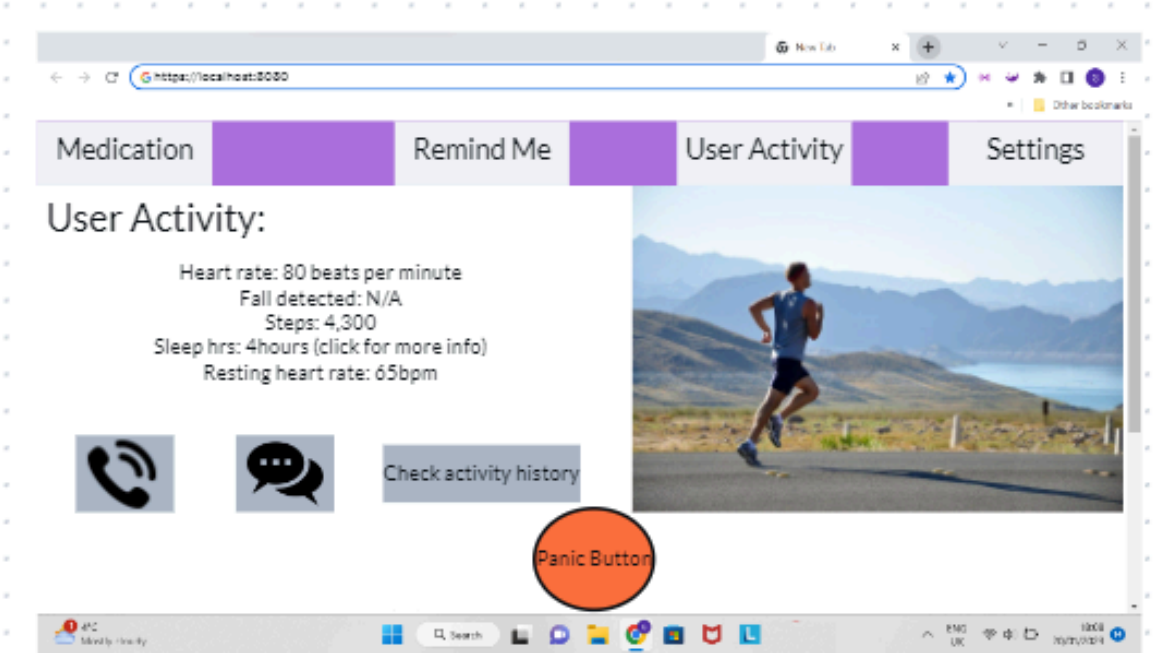


[Figure 5.6 - medication feature iteration 2]

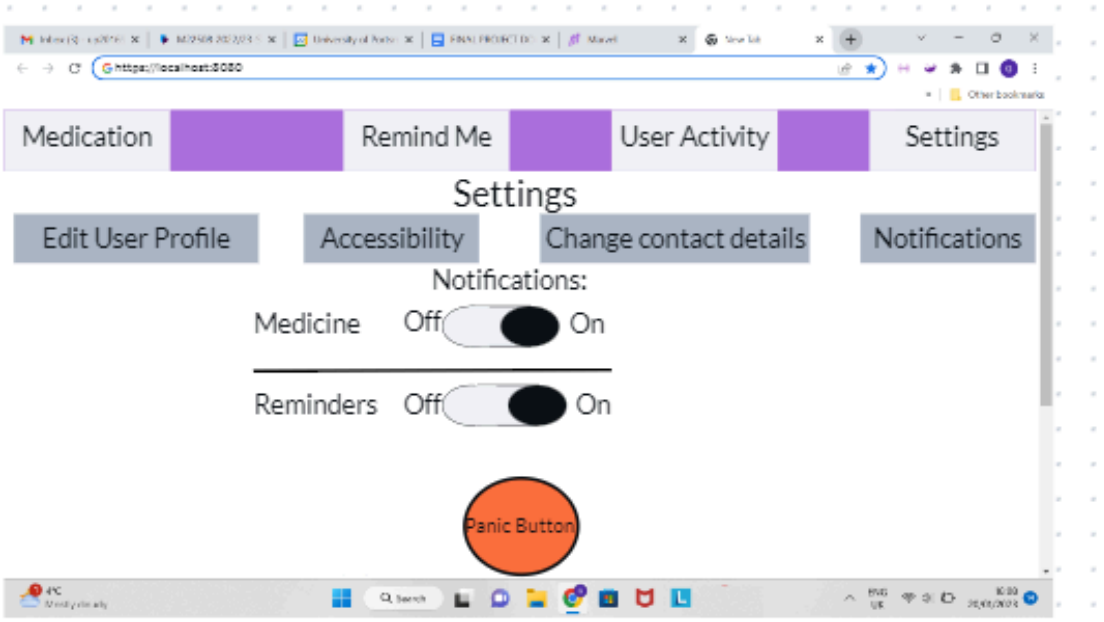


[Figure 5.7 - Reminder section iteration 2]

This is the reminder section which lists the recorded events the user can note down and it can be split from today's events to future upcoming events.

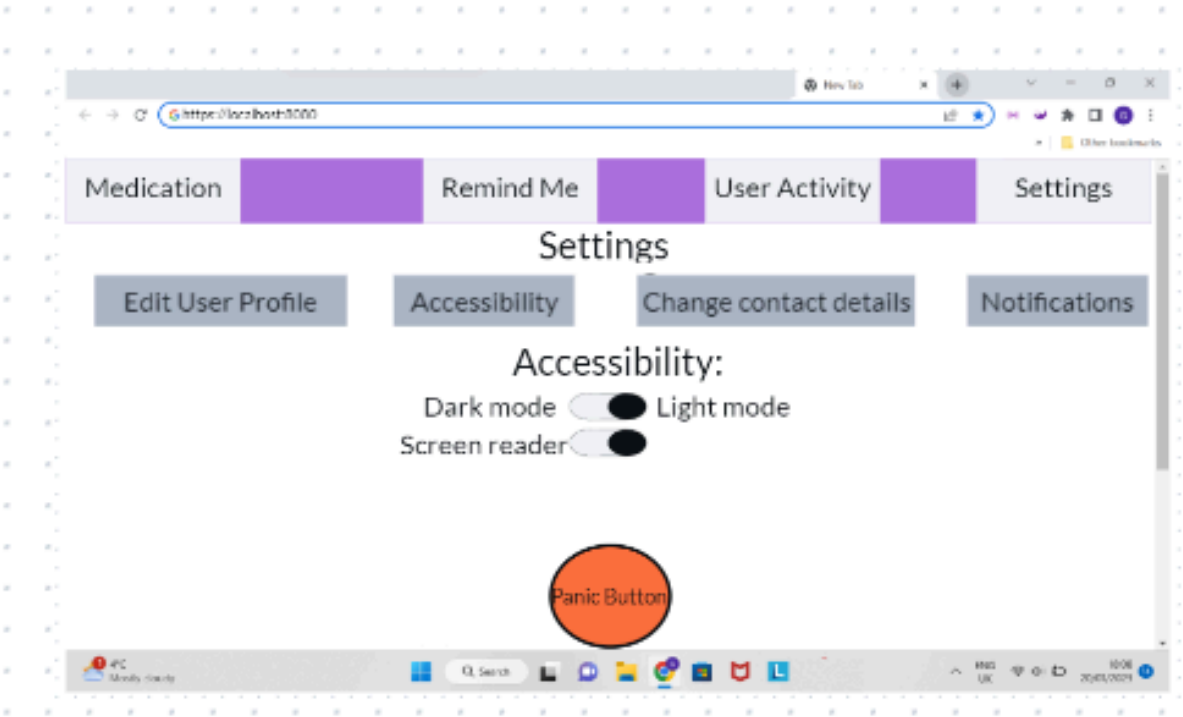


[Figure 5.8 - My activity iteration 2]



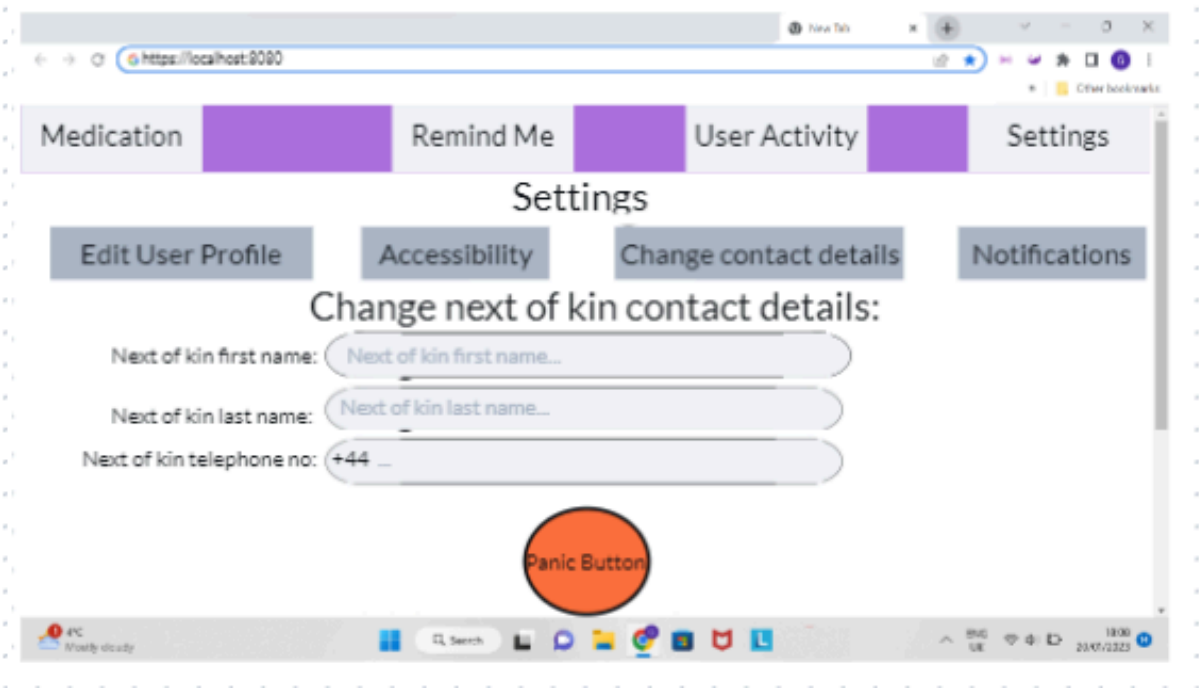
[Figure 5.9 - Settings Notification menu iteration 2]

This demonstrates the toggle features where you can disable or enable posting notifications and allows the user to access the different range of settings bars once opened.

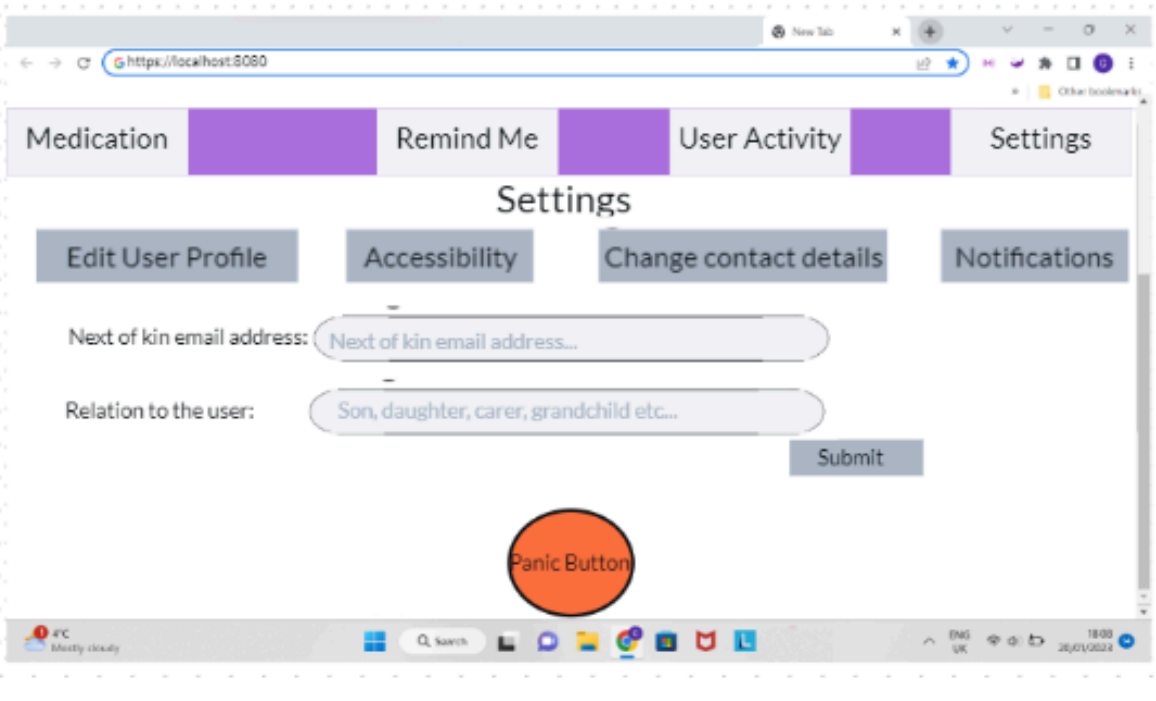


[Figure 5.10 - Accessibility settings iteration 2]

This shows the different settings available for the application such as a screen reader and enabling dark or light mode.



[Figure 5.11 - emergency contact details scroll 1]



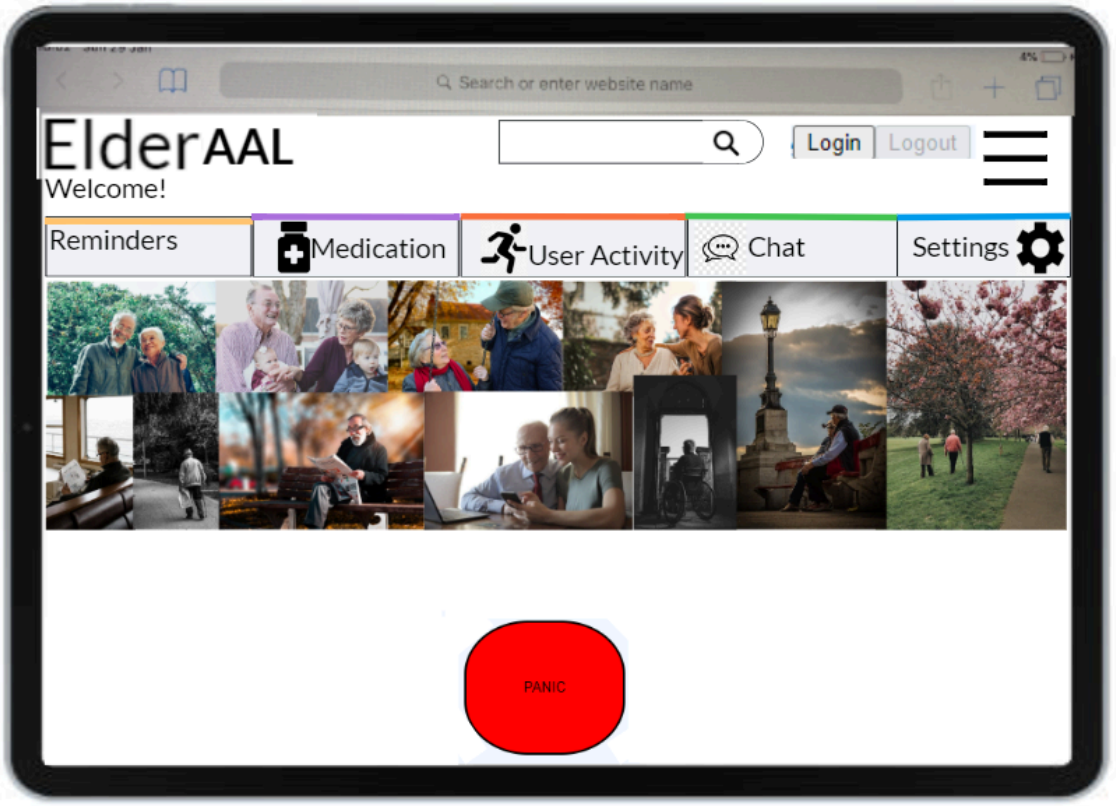
[Figure 5.12 - emergency contact detail scroll 2]

Following from the previous iteration, feedback was given based on the prototypes produced.

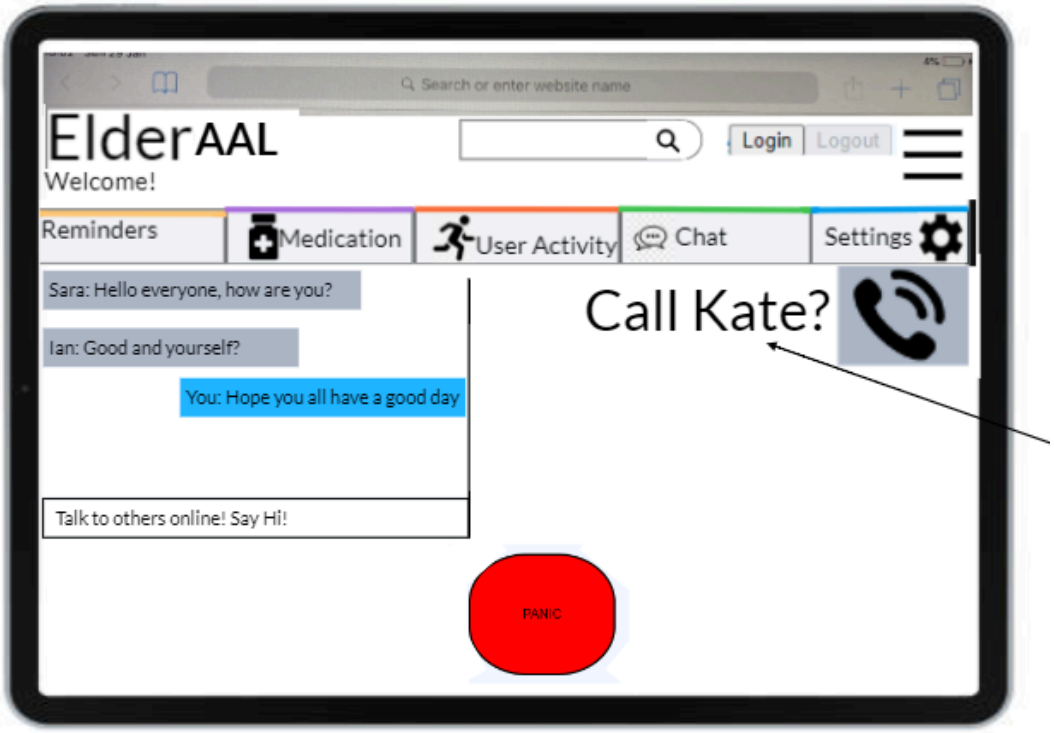
The feedback for iteration 2:

- Pink/purple is a bad choice of colour scheme.
- Login/logout is not clear
- Settings page - scroll for the submit is confusing, user may think the panic button is the submit button

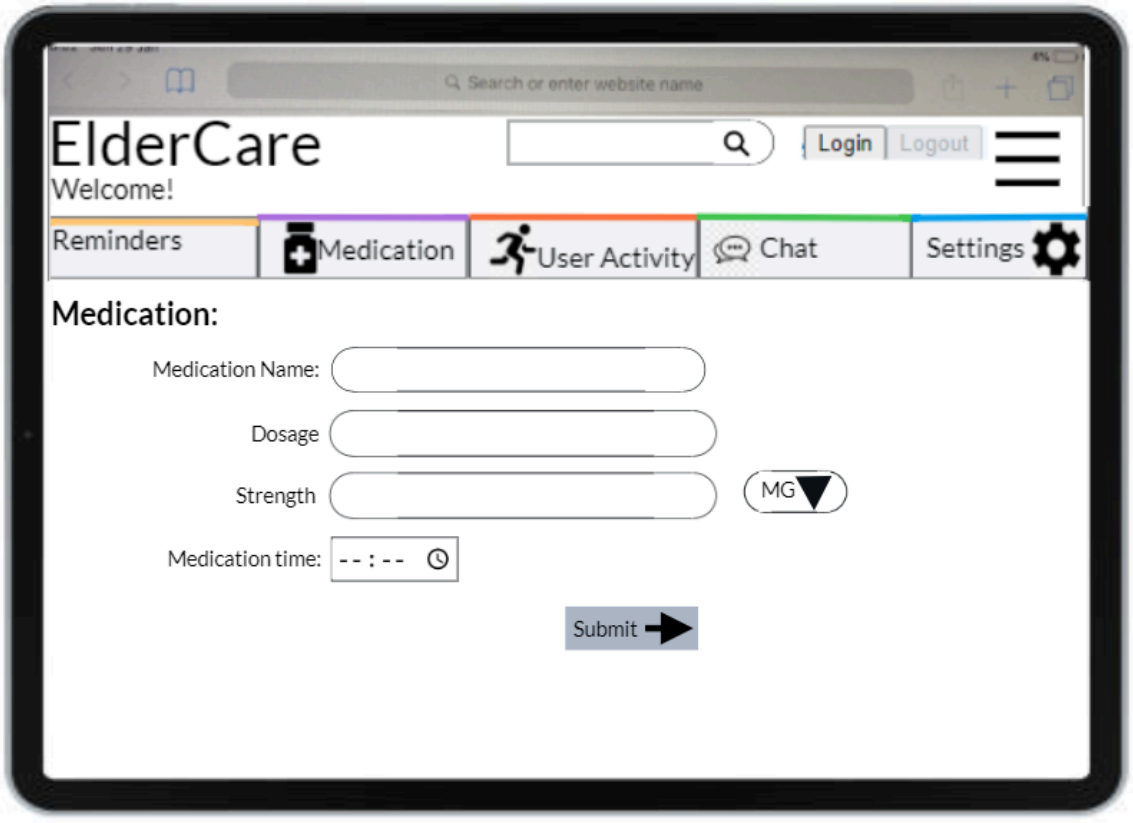
Iteration 3:



[Figure 5.14 - Homepage iteration 3]



[figure 5.15 - Chat section]



[Figure 5.16 - Medication]

Research/feedback on the medication feature:

The discovery of the BNF and NICE guidelines has allowed for a better understanding that dosage and strength may need to be clearly defined and should follow the user's natural language.

Moreover, the client had also described that users may take medication at different intervals (varying from days to weeks), therefore this should be taken into consideration when creating the final artefact.

Feedback:

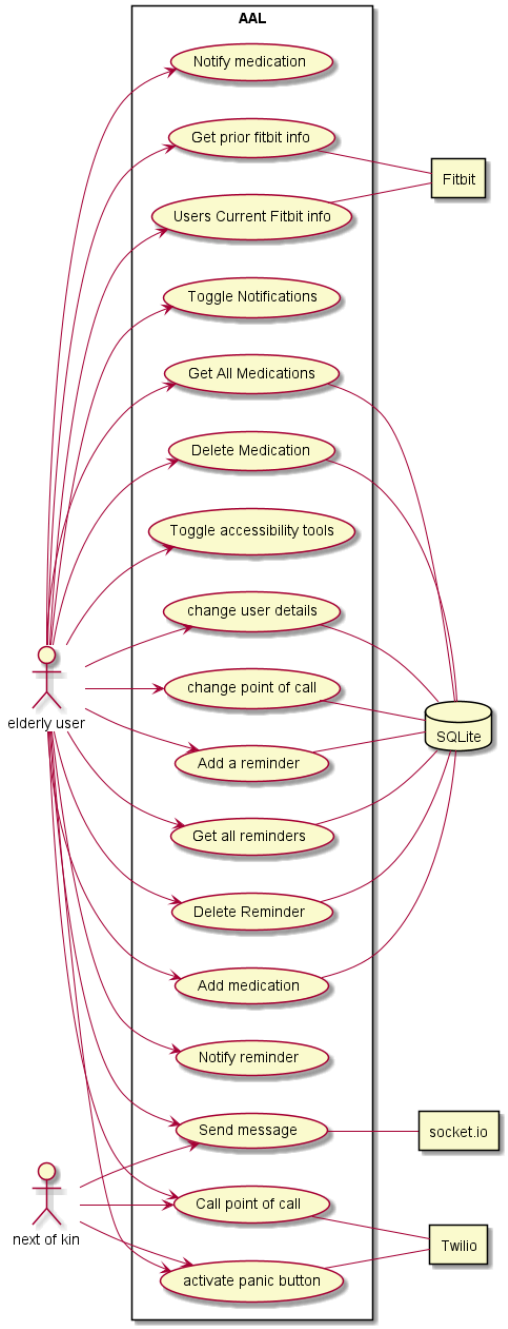
- The medication dosage/strength is confusing
- Should have a homepage where the user can go back.
- Medication type should also be clearly stated in the application.
- Have one big picture rather than many because it can be overwhelming for the user.

Throughout this process, full utilisation of the kanban board was made where the design would be moved between stages. From “under development” to “to be reviewed” to “complete” until the user had accepted the item with no concerns.

Use Cases

The use cases have showcased the evolution of what functionality is available in the application. A larger amount of functionality was established initially however as iterations progressed this had reduced as the main functionality was prioritised.

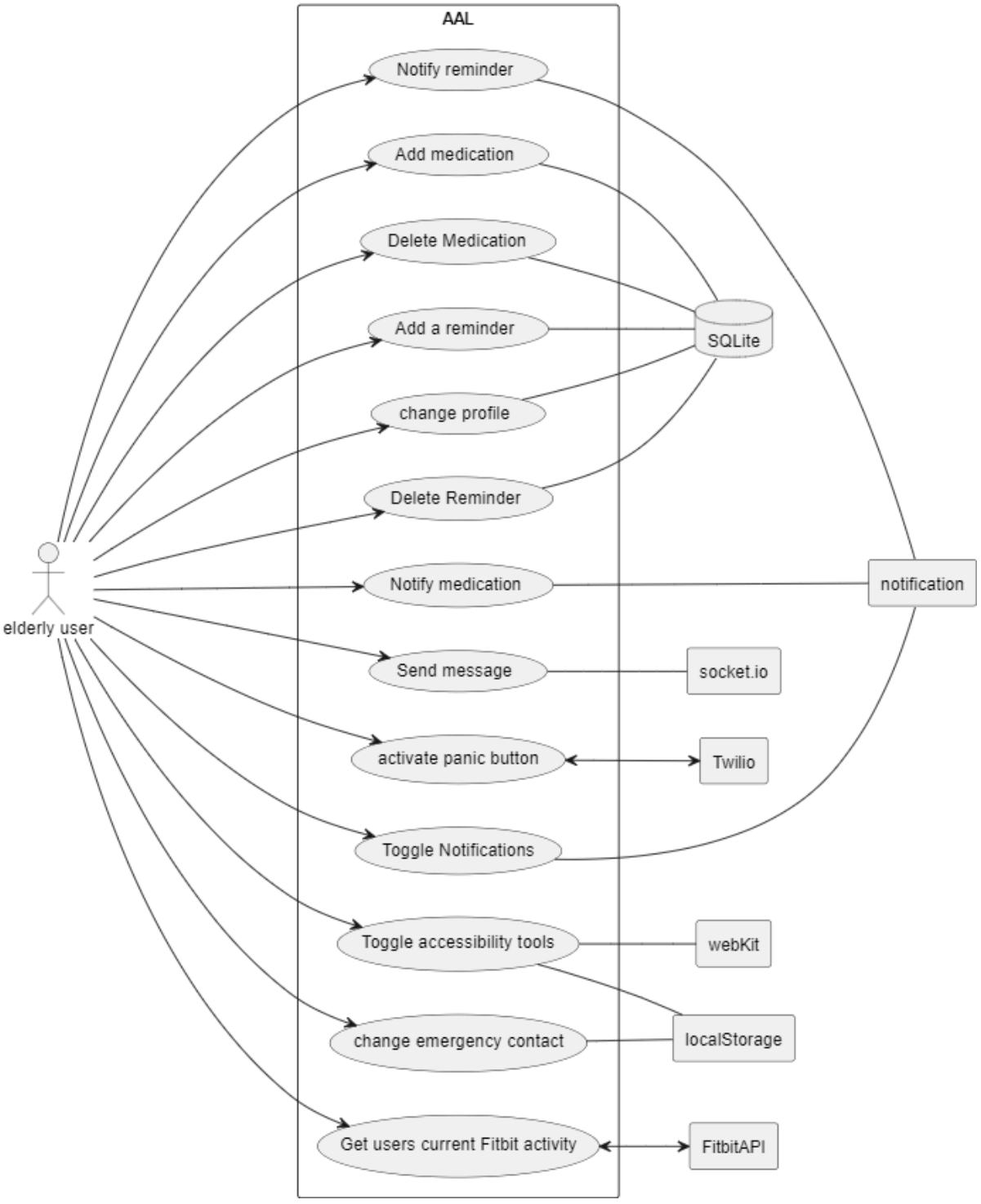
Iteration 1:



[Figure 5.17 - PLANTUML]

The initial design had enabled the user to do a lot of different features with the application. However, as time had progressed more emphasis was placed on the delivery of the user interface for the elderly user; this became the centre of attention during the development stages.

Iteration 2:

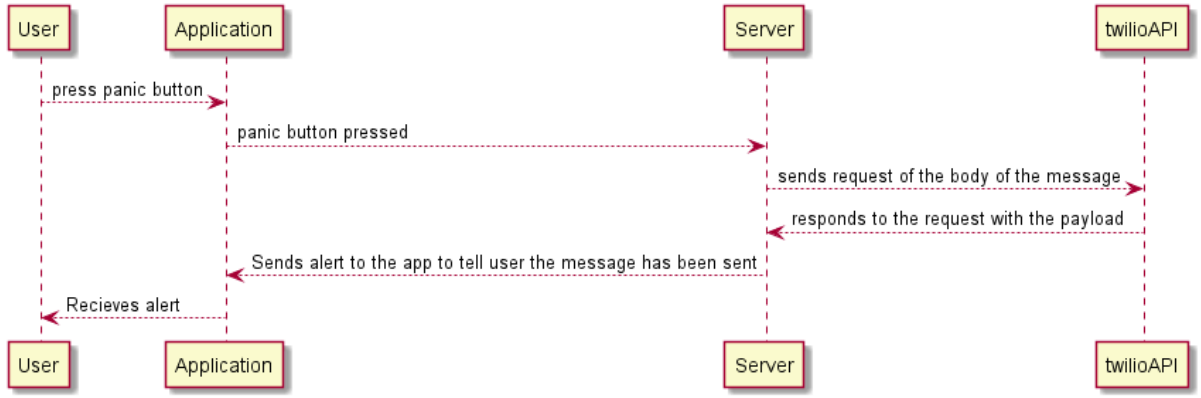


[Figure 5.18 - PLANTUML iteration 2]

Sequence Diagram:

Panic Button

Iteration 1:

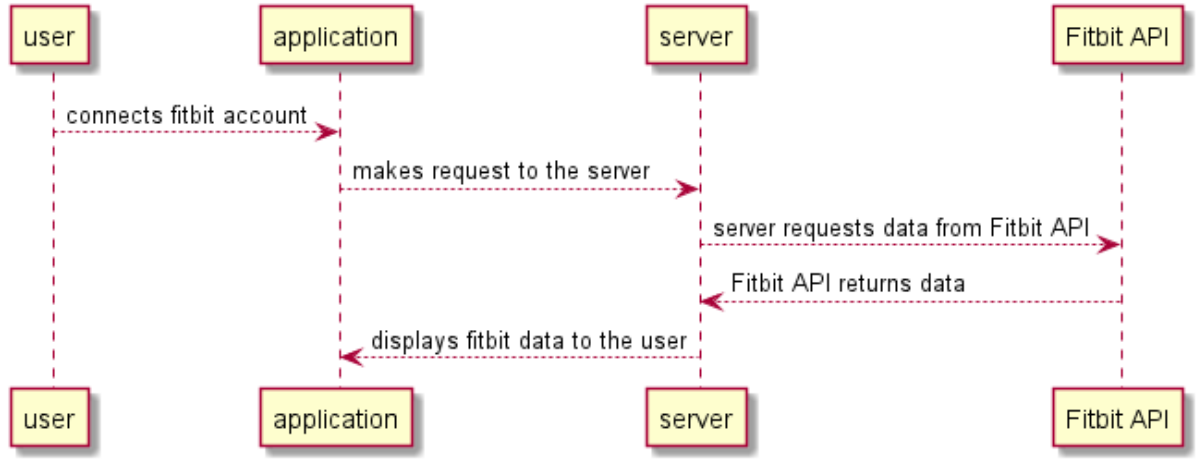


[Figure 5.19 - sequence diagram twilio]

The twilioAPI would use the phone number assigned via Twilio and will send it to the number requested with the body as the message.

Fitbit Connection

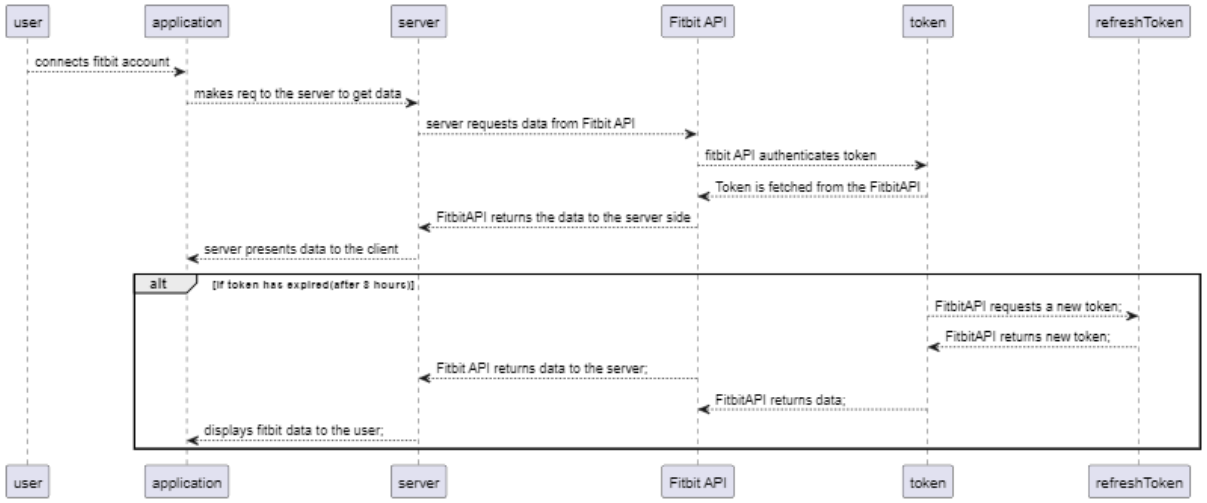
Iteration 1:



[Figure 5.20 - sequence diagram FitbitAPI]

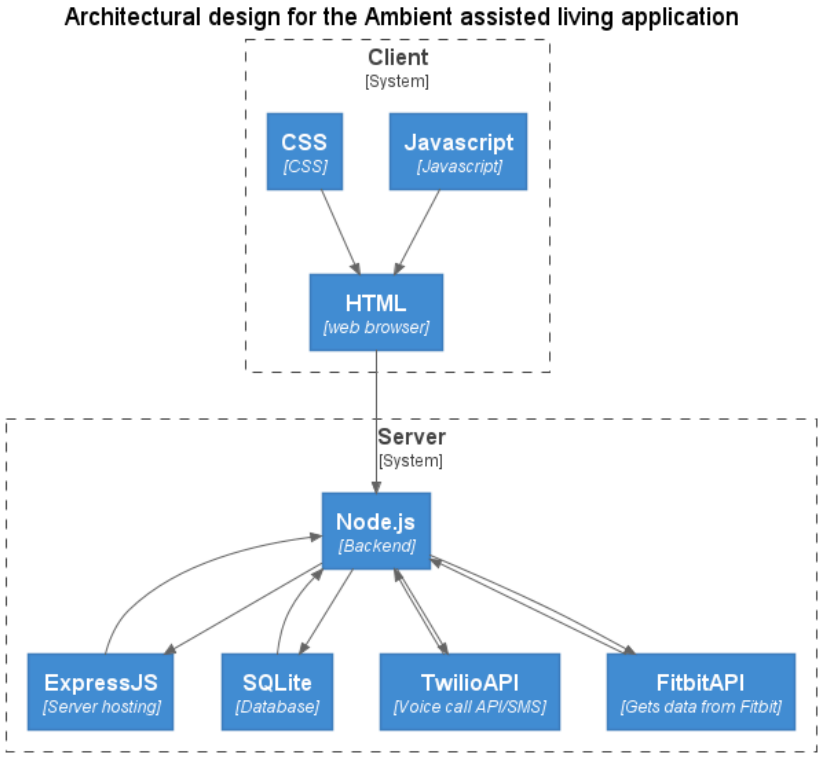
With further awareness of how the FitbitAPI works, there was further development of the UML diagram.

Iteration 2:



[Figure 5.21 - Sequence diagram FitbitAPI iteration 2]

System architecture



[Figure 5.22 - system architecture]

Designing for Accessibility:

Overview of Accessibility

Accessibility plays a crucial role in website development. It is important to make websites accessible to all users as it can generate higher website traffic from various demographics with varied abilities. Accessibility plays a crucial role in the development of this application due to its target audience and for allowing inclusivity to websites (Tim Bernes Lee n.d).

Target Audience

For the application the main audience is the elderly however within this age group(65+) there are many different medical conditions that must be catered for, according to the w3c.org including the following list:

- Visual impairments
- Speech impairments
- Cognitive disabilities
- Auditory impairments
- Neurological disorders
- Physical disabilities

(Montgomery, 2020)
The table shown below can allow for equal access and can create a universal design.

Impairment	Accessibility facility
Visual impairments	Auditory support Speech to text support Dark mode - feature designed for individuals who are unable to see bright-lights.
Speech impairments	The application allows for text to be put in when communicating with the application.
Cognitive disabilities	Prompts to help the user navigate the website.
Auditory issues	Text on screen
Neurological disorders	• Create a clear and concise layout where the user can see what each function does. • Providing consistent navigation throughout the application. • Keyboard accessibility - so that all the functions do not necessarily have to be done within a click of a mouse.
Physical disabilities	The application should be accessible with minimal requirement for mouse movement.

Design Considerations

The font size should be able to adjust to the user's preference as they will have access to a settings page shown by the previous diagrams. They can also amend things such as the font according to their preference. The colour scheme will be a light background with dark text for a contrast - however the user can edit their preferences for the background colour and can set it to dark and lightmode. Alts will also be used in images to help those with disabilities to understand the context of the image.

Compliance Testing

Tests have been conducted on the target audience to receive feedback and outline any improvements required. Questions will be directed to both potential clients and users about the accessibility of the software. This has helped understand the current status of the software and how well they can access it.

Accessibility Standards Used

With further research in accessibility standards, an understanding of the three levels of conformance had been established. The application aimed to cater to level AAA of conformance where it allowed people with severe disabilities to use the application. The accessibility tools have been shown in the requirements section for how this will be catered to the audience. Furthermore alternative texts, easy navigation and a clear structure will be followed in the design of the system.

Level AAA

- Clear structure of navigation
- High contrast
- Provide alternative images texts
- Provide microphone for those who cannot see the content displayed on the website or those with low vision that may require text to speech
- Allow for keyboard navigation

Chapter 6:

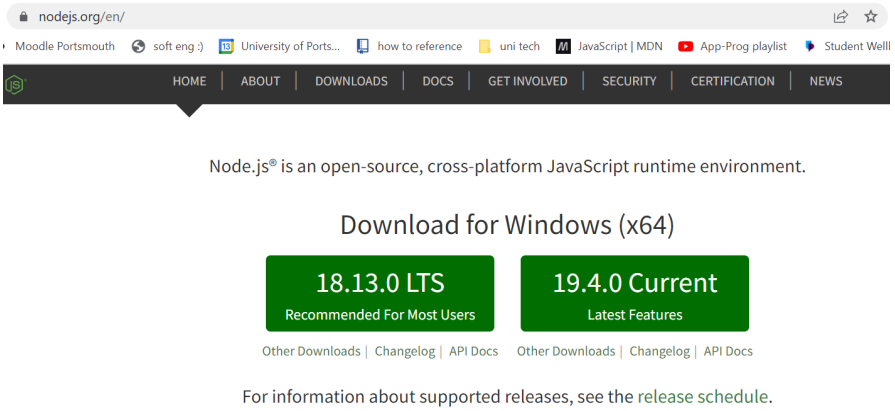
Implementation and testing

Implementation and testing have been merged into one section as it reflects the agile approach which was used throughout the process.

Installation dependencies:

I had used NodeJS as it is a Javascript runtime environment which lets developers run server side code and it has large popularity and has wide availability on the internet by many users. The application can also be available offline by downloading the application.

NodeJS was installed during the initial development stages. The figure below shows the current version and LTS (long term support) version of the software. For the development the LTS version was downloaded as there is wider community support compared to the current version and LTS provides more stability. Therefore if support was required, it would be more efficiently accessible.



[Figure 6.1- Node installation]

Package Dependencies

NPM(node package manager) was used when downloading packages, this was automatically installed with NodeJS. NPM contains many different packages with its documentation readily available on the internet.

NPM dependencies

```
npm i jest
npm i sqlite3
npm i express
npm i sqlite
```

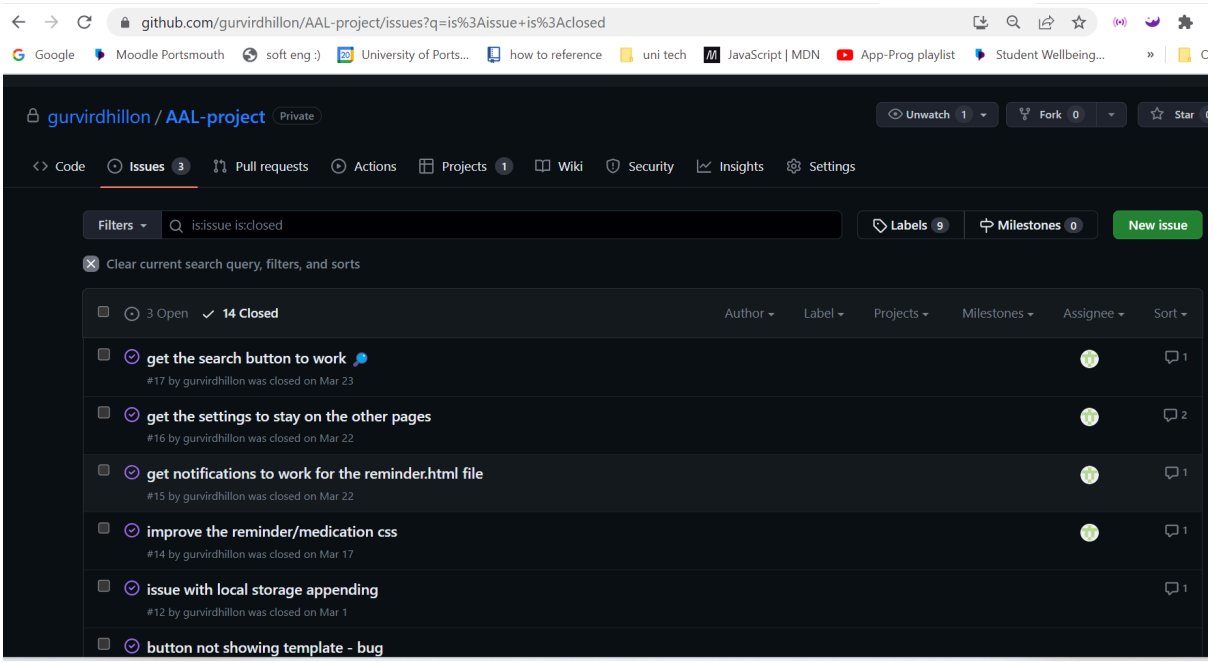
```
npm install twilio
npm i socket.io
npm install socket.io
npm i nodemon
npm i jest-localstorage-mock
npm i oauth2orize
npm i passport
npm i passport-fitbit-oauth2
```

Testing dependencies

```
npm install jest --global
```

GitHub - version control management

GitHub had been used to store the artefact and all its related work (including the Plantuml diagrams shown earlier. Furthermore, GitHub had also stored the kanban board where development visualisation was shown. Github had many benefits including the use of github issues to remind the researcher for issues that are currently persisting/need fixing. This had also allowed for easier retracing of previous issues and reopening previous bugs.



[Figure 6.2 - Github issues]

Github Branches

Branches were used in development to avoid the clashing of the different features that were developed in parallel. Once a feature was developed and was ready for a release, it was merged to the main branch and the environment was run and tested to see if any issues

occurred. Then the features were tested before returning to the next stage of development/iteration.

Linting

ESlint was used in the development of the application as it provides a standardised quality of coding and restructuring benefits by syntax highlighting any texts that do not align or syntax that can be presented better. Furthermore, bad coding practice including var would be avoided as this can lead to poorer code quality. The portsoc configuration of ESlint was used:

```
npm i --save-dev eslint eslint-config-portsoc
```

Iteration Plan:

The iteration plan focused on continuous feedback from the stakeholders. The features were continuously improved through feedback and this changed the code structure and what was placed into the artefact. This would happen consistently throughout the system build and seeking customer acceptance was crucial before moving onto the next feature.

Iteration 0 - Home feature/basic UI outline

The feedback received was based on the design, the design was implemented and the users were happy with the user interface made.

Reminder Feature and Medication Feature Implementation

Both features relied on the use of notifications that are supported by the web via a notification API. The web API has heavy support including chrome, edge, firefox and safari. The API works via gaining the time, the date and the prompt(whatever data is being stored) and this works asynchronously by sending out the notification when the time and date requested is met.

The reminder and medication feature are saved in local storage for the user to gain access to the application after it is closed and once reopening the app again it will remember what has been previously inputted. This can potentially lack maintainability as it is stored in the client however, future works will include the maintenance of a database which has been introduced on server side however it is not fully integrated within the application as no real data is being inputted. In future the use of the POST method from the requested data from the client to the server will allow for data to be stored.

Integration Testing:

The test had to use an external dependency for jests local storage. This is important as the test had failed before due to the framework being unable to recognise the syntax of local storage. This tests to see if the notification feature works with 3 examples including the reminder, the date and the time.

```
describe('Adding reminder to local storage', () => {
  test('local storage should hold the input, date and time', () => {

    const reminder = 'Test reminder';
    const date = '2023-04-12';
    const time = '10:30';

    localStorage.setItem('reminder', reminder);
    localStorage.setItem('date', date);
    localStorage.setItem('time', time);

    const storedReminder = localStorage.getItem('reminder');
    const storedDate = localStorage.getItem('date');
    const storedTime = localStorage.getItem('time');

    expect(storedReminder).toEqual(reminder);
    expect(storedDate).toEqual(date);
    expect(storedTime).toEqual(time);
  });
});
```

Panic Button Implementation

The panic button had used the TwilioAPI which allows for messages to be sent from the web application to the chosen mobile phone. A default mobile phone number was given to the application as the sender for free by Twilio.
This was developed in stages. At first the message would be sent every time the server ran. Shown by the code below:

Iteration 0:

```
import twilio from 'twilio';
const accountSid = "ACf25d4feac6b0fd768188a7f2d54f5583";
const authToken = "3562338dc6f76a2f6a83f6a4eddddec4";
const client = twilio(accountSid, authToken);
client.messages
```

```
   .create({
       body: 'Testing',
       from : '',
       to: ''
}).then(message => console.log(message.sid));
```

The above code was taken from the GitHub repository that shows the project history. This code initially sent a “Testing” message from TwilioAPI whenever the user would open the application. But this was not yet connected to the panic button therefore further edits had been made to allow this.

Iteration 1:

```
async function activatePanicButton() {
  const panicBtn = document.querySelector('#panicBtn');
  panicBtn.addEventListener('click', async () => {
        const response = await fetch('/send-message', {
        method: 'POST',
        headers: {
          'Content-Type': 'application/json',
        },
        body: JSON.stringify({
          body: 'Help me!',
          from: '',
          to: '',
      });
      alert('Message sent to next of kin');
      const data = await response.json();
    } else {
      alert('Message not sent');
    }
  });
  const data = await response.json();
  console.log(data);
}

window.addEventListener('load', activatePanicButton);
```

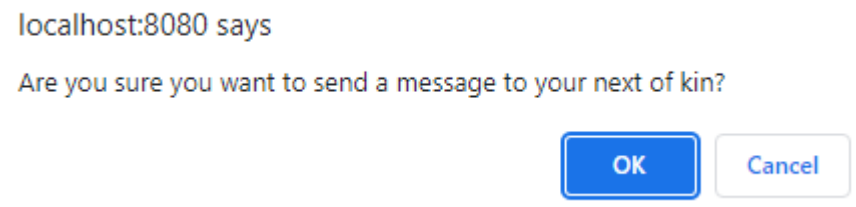
(Twilio API n.d)

This function had allowed the user to send a message to their next of kin if further assistance was required. However, this functionality lacked the ability to prevent mistakes. Therefore, the choice was made to add in extra boundaries which would help prevent the user from making further mistakes.

Iteration 2:

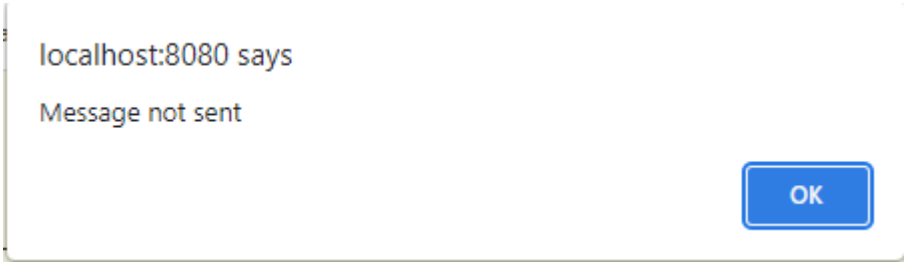
```
// document.addEventListener('DOMContentLoaded', () => {
async function activatePanicButton() {
  const panicBtn = document.querySelector('#panicBtn');
  panicBtn.addEventListener('click', async () => {
    const check = confirm('Are you sure you want to send a message to
your next of kin?');
    if (check) {
      const response = await fetch('/send-message', {
        method: 'POST',
        headers: {
          'Content-Type': 'application/json',
        },
        body: JSON.stringify({
          body: 'Help me!',
          from: '',
          to: '',
        }),
      });
      alert('Message sent to next of kin');
      const data = await response.json();
    } else {
      alert('Message not sent');
    }
  });
  const data = await response.json();
  console.log(data);
}
window.addEventListener('load', activatePanicButton);
```

Similar to the previous code however, this had extra precautions by providing the user with a warning beforehand where they can “Cancel” if this was a mistake or press “OK” to continue.



[Figure 6.3]

Furthermore, based on the response. It would update the user and tell them if the message was sent or if it was not sent. If the user clicks cancel the following appears:



[Figure 6.4]

If the user had clicked “OK”, this message would appear to alert the user that the message had been received:

[Figure 6.5]

The button was placed on the bottom corner of the page where the user can navigate the button. The placement of the button will also be a key aspect of the testing phase where the user will be asked if they can navigate the button. If unsuccessful, the user will be asked where they would prefer the button to be on the application. Continuous feedback was seeked throughout the project by potential clients.

Due to financial constraints the TwilioAPI functionality was time limited therefore the ability to send messages were disabled after the free trial had ended.

User Testing Results:

Users were able to navigate the button however, the users were confused about the layout of the alert. Therefore better presentation of the alert will be prioritised and ensuring it is clear what the user is doing on the application.

Settings/Accessibility Implementation

Microphone Speech Compatibility

The users have a range of abilities when using the application. The application aims to provide diverse user groups the same ability to use the app. Therefore microphone speech compatibility as explained earlier allows users to access the same resources on the page. This application may be limited by permissions as web applications typically require user consent for using a microphone.

A web speech kit recognition tool had been used to integrate the microphone ability. The first point of getting the web speech kit to work was to be able to generate the speech in the console.

Web kit speech recognition has a high level of compatibility and works alongside many browsers including Safari, Google Chrome, Opera and Edge.

```
window.speechRecognition = window.speechRecognition ||
window.webkitSpeechRecognition;
const recognition = new window.speechRecognition();
recognition.interimResults = true;

const getInput = document.querySelector('#searchInput');

recognition.addEventListener('result', (e) => {
  const voiceInput = Array.from(e.results)
    .map((result) => result[0])
    .map((result) => result.transcript)
    .join('');
  console.log(voiceInput);
});

recognition.addEventListener('end', recognition.start);
recognition.start();
```

This code shows the window loading the web kit and it places it into a transcript in the console as an array.

To test the functionality, the getInput button was pressed and the following was stated “Hello this is a test to see if this functionality works”.

[Figure 6.6 - microphone feature functionality]

Iteration 2:

This has shortly been transferred over to the input field which has been changed to monitor certain keywords including medication, help, reminder, fitness, settings, chat and many more. This is to help increase the efficiency of navigation for the user.

```
// Speech recognition app using Vanilla JavaScript. YouTube. (2020,
August 27).
// Retrieved from https://youtu.be/-k-PgvbktX4

document.addEventListener('DOMContentLoaded', () => {
window.speechRecognition = window.speechRecognition ||
window.webkitSpeechRecognition;

const recognition = new window.speechRecognition();
recognition.interimResults = true;

const getInput = document.querySelector('#searchInput');
const microphoneButton = document.querySelector('#microphone');

recognition.addEventListener('result', async (e) => {
  const voiceInput = Array.from(e.results)
    .map((result) => result[0])
    .map((result) => result.transcript)
```

```
    .join('');
    getInput.value = voiceInput;
  // console.log(voiceInput);
  if(voiceInput === 'help me'){
    // get the panic button to send a message to the next of kin
    await fetch('/send-message', {
      method: 'POST',
      headers: {
        'Content-Type': 'application/json'
      },
      body: JSON.stringify({
        body: 'Help me!',
        from: '',
        to: ''
      })
    });
    alert('panic button activated');
  } if (voiceInput === 'medication' || voiceInput === 'meds' ||
voiceInput === 'medicine' || voiceInput === 'tablets' || voiceInput ===
'pills'){
    window.location.href = 'medication.html';
  } if (voiceInput === 'reminders' || voiceInput === 'reminder'){
    window.location.href = 'reminder.html';
  } if (voiceInput === 'activity' || voiceInput === 'fitness'){
    window.location.href = 'activity.html';
  } if (voiceInput === 'chat' || voiceInput === 'message' || voiceInput
=== 'messages'){
    window.location.href = 'chat.html';
  }
});

if(microphoneButton !== null) {
    microphoneButton.addEventListener('click', () => {
    recognition.start();
  });
}

recognition.addEventListener('end', () => {
  recognition.start();
});
});
```

User Testing:

A bug was spotted in the microphone feature where the functionality works even after the user is done with the feature until a search has been performed. This could present problems as users may not wish to have a microphone to be activated for long periods of time. Therefore further development will be done to avoid this in the next iteration of the application.

This had been further improved in iteration 3 of the application. Where the user can cancel the use of the microphone feature. This improvement allows for a greater error reduction rate. Users also described a familiarity with other applications which allows for pressing the button twice to cancel the microphone feature.

Iteration 3:

```
document.addEventListener('DOMContentLoaded', () => {
  window.speechRecognition = window.speechRecognition ||
window.webkitSpeechRecognition;

  const recognition = new window.speechRecognition();
  recognition.interimResults = true;

  const getInput = document.querySelector('#searchInput');
  const microphoneButton = document.querySelector('#microphone');

  let listenEvent = false;

  microphoneButton.addEventListener('click', () => {
    if (!listenEvent) {
      recognition.start();
      microphoneButton.classList.add('active');
      listenEvent = true;
    } else {
      recognition.abort();
      microphoneButton.classList.remove('active');
      listenEvent = false;
    }
  });
  recognition.addEventListener('result', async (e) => {
    const voiceInput = Array.from(e.results)
      .map((result) => result[0])
      .map((result) => result.transcript)
      .join('');
```

```
    getInput.value = voiceInput;
    // console.log(voiceInput);
    if (voiceInput === 'help me') {
      // get the panic button to send a message to the next of kin
      await fetch('/send-message', {
        method: 'POST',
        headers: {
          'Content-Type': 'application/json',
        },
        body: JSON.stringify({
          body: 'Help me!',
          from: '',
          to: '',
        }),
      });
      alert('panic button activated');
    } if (voiceInput === 'medication' || voiceInput === 'meds' ||
voiceInput === 'medicine' || voiceInput === 'tablets' || voiceInput ===
'pills') {
      window.location.href = 'medication.html';
    } if (voiceInput === 'reminders' || voiceInput === 'reminder') {
      window.location.href = 'reminder.html';
    } if (voiceInput === 'activity' || voiceInput === 'fitness') {
      window.location.href = 'activity.html';
    } if (voiceInput === 'chat' || voiceInput === 'message' ||
voiceInput === 'messages') {
      window.location.href = 'chat.html';
    }
  });

  recognition.addEventListener('end', () => {
    if (listenEvent) {
      recognition.start();
    }
  });
});
```

This had been accepted by the client.

Text to speech

This feature utilised a speech synthesiser to explain what is on the screen to the user. This is especially useful to those who have low vision. The text to speech feature was created within the first iteration.

```
document.addEventListener('DOMContentLoaded', () => {
  const reader = document.querySelector('.reader');
  reader.addEventListener('click', () => {
  const synthesis = window.speechSynthesis;
    const getGreeting = document.querySelector('#greeting');
    const vocal = new
SpeechSynthesisUtterance(getGreeting.textContent);
  synthesis.speak(vocal);
});
});

document.addEventListener('DOMContentLoaded', () => {
  const activateVoice =
document.querySelector('#activitySummaryVoiceOver');
  activateVoice.addEventListener('click', () => {
    const synthesis = window.speechSynthesis;
    const gatherMetaData = document.querySelector('#analyseData');
    const vocal = new
SpeechSynthesisUtterance(gatherMetaData.textContent);
    synthesis.speak(vocal);
  });
});
```

This allows for a voice over to be done for whenever the user requires information to be extracted. This provides certain voice overs for different needs.

My activity/fitbit Integration Implementation

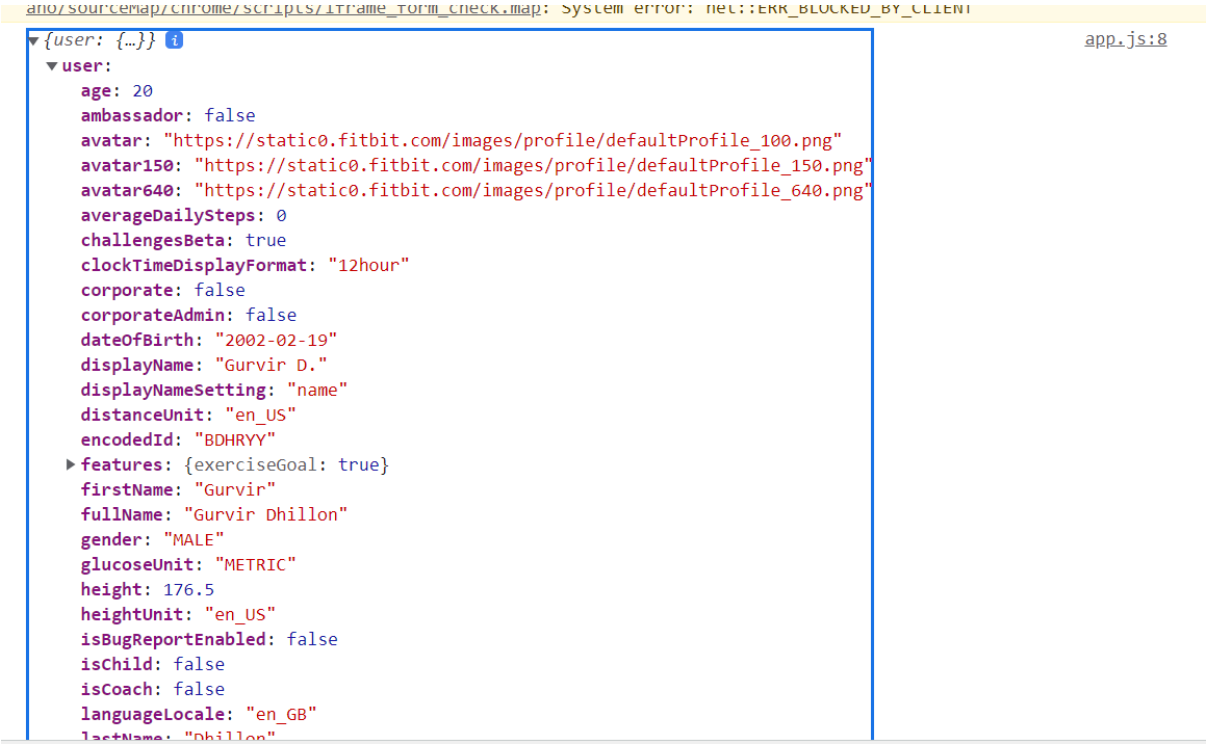
Iteration 1:
The fitbit API had been utilised and further development had shown auth0 2.0 compatibility will be required as this provides a request for certain data from the application. With further development and learning, the understanding of the access token has shown that the application will only provide the fitbit data for a maximum of 8 hours before a refresh token is required.

```
fetch('https://api.fitbit.com//1/user/-/profile.json', {
    method: "GET",
    headers: {"Authorization": "Bearer " + access_token}
})
.then(response => response.json())
```

```
.then(json => console.log(json));
```

This code fetches the users data from their profile and displays it to the user with information. The data had been logged to the console with information being fed back to the user.

The path route was taken from the API website.



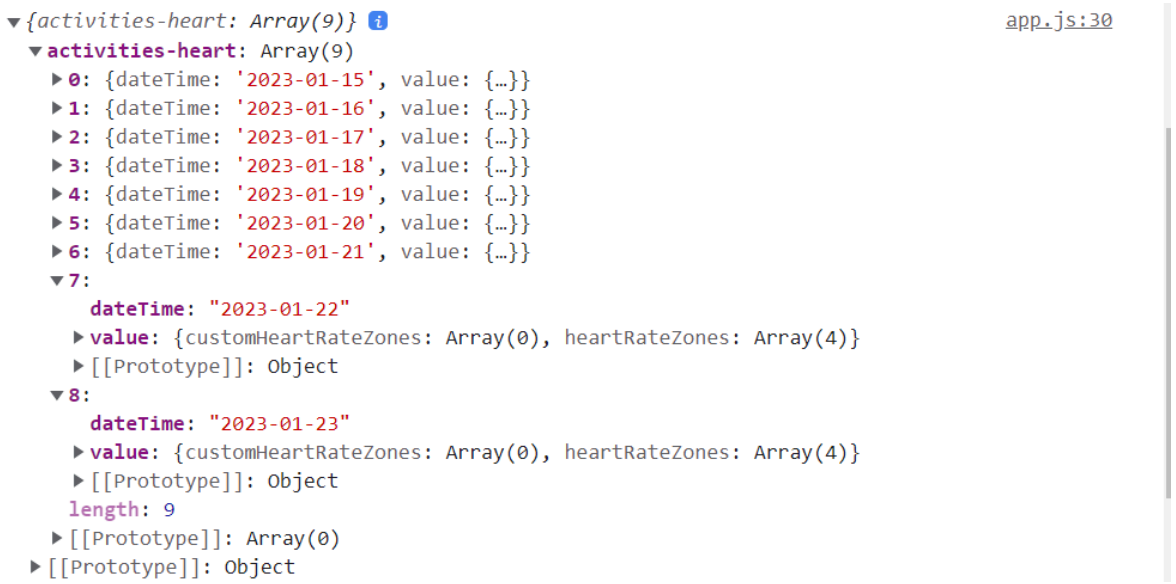
[Figure 6.7 - fitbit data gathering]

As can be seen this is information about the user and the smartwatch. This was requested from the web application to the watch and after integrating auth0 2.0 this will gain the data autonomously.

```
const grabData =
fetch('https://api.fitbit.com/1/user/-/activities/heart/date/2023-01-15
/2023-01-23.json', {
    method: "GET",
    headers: {"Authorization": "Bearer " + access_token}
})
.then(response => response.json())
.then(json => console.log(json));
```

(Fitbit Web API 2023)

This had shown the watches activity during the time commencing between these dates.



[Figure 6.8 - Fitbit data gathering]

The application shows no data due to the watch being new however if the fitbit was worn this data would be displayed.

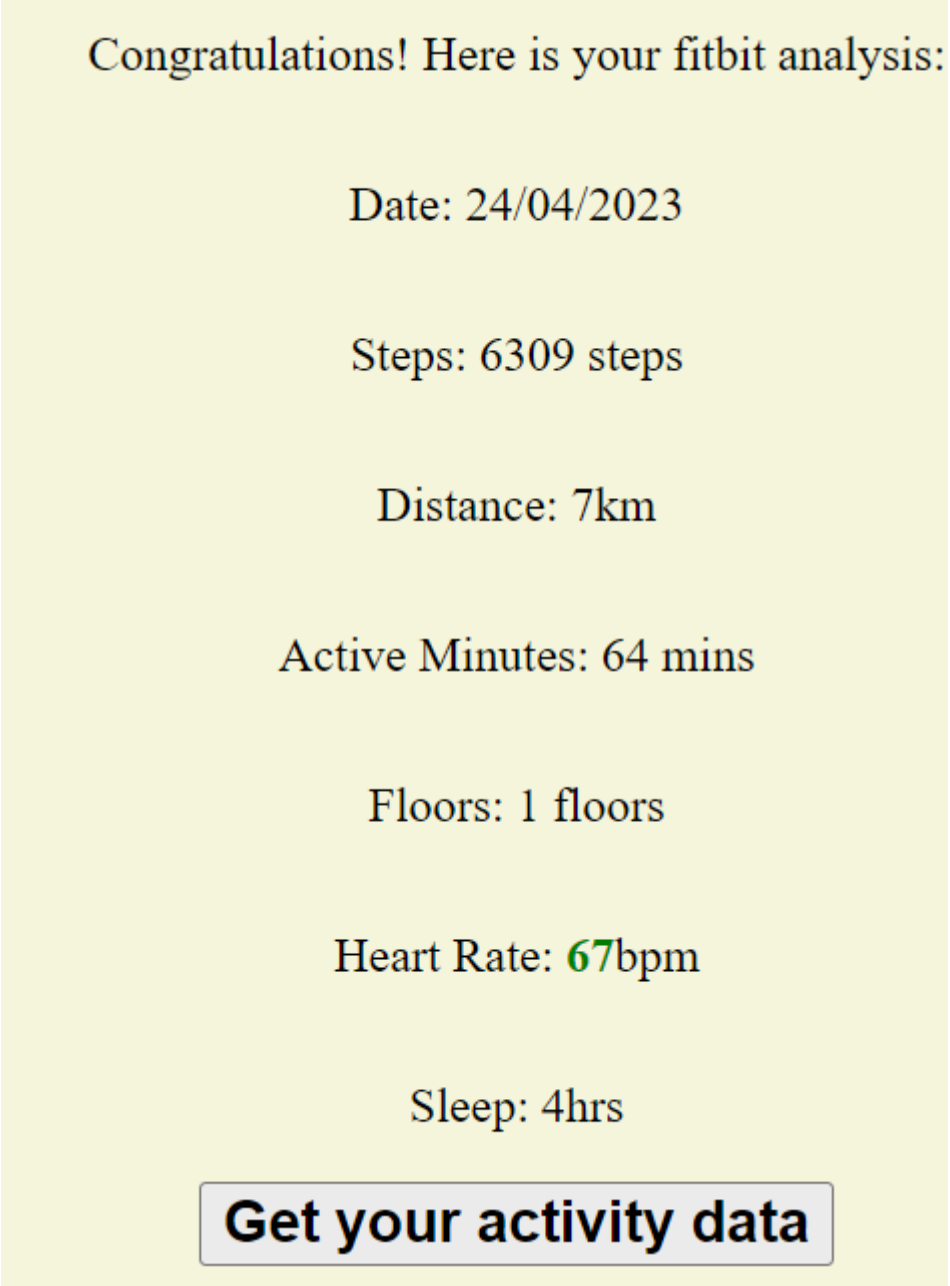
Iteration 2:

Due to time constraints and the complexity of auth0 2.0 integration, placeholder data was utilised using math.random and calculations made by javascript.

```
document.addEventListener('DOMContentLoaded', () => {
  const getBtn = document.querySelector('#getStats');
  const stepsCount = document.querySelector('#stepsCount');
  const distanceCount = document.querySelector('#distanceCount');
  const activeMins = document.querySelector('#activeMins');
  const floorsCount = document.querySelector('#floorsCount');
  const heartRate = document.querySelector('#heartRate');
  const sleepQuality = document.querySelector('#sleepQuality');
  const currentDate = document.querySelector('#date');

  getBtn.addEventListener('click', () => {
    currentDate.textContent = new Date().toLocaleDateString();
    stepsCount.textContent = Math.floor(Math.random() * 10000);
    distanceCount.textContent = Math.floor(Math.random() * 10);
    activeMins.textContent = Math.floor(Math.random() * 100);
    floorsCount.textContent = Math.floor(Math.random() * 10);
    heartRate.textContent = Math.floor(Math.random() * 100);
    if (heartRate.textContent < 60) {
      heartRate.style.color = 'red';
      heartRate.style.fontWeight = 'bold';
    } else if (heartRate.textContent > 60 && heartRate.textContent <
100) {
```

```
      heartRate.style.color = 'green';
      heartRate.style.fontWeight = 'bold';
    } else if (heartRate.textContent > 100) {
      heartRate.style.color = 'red';
      heartRate.style.fontWeight = 'bold';
    }
    sleepQuality.textContent = Math.floor(Math.random() * 12);
  });
});
```

The button then performs calculations once clicked and for each querySelector data is put in accordingly.



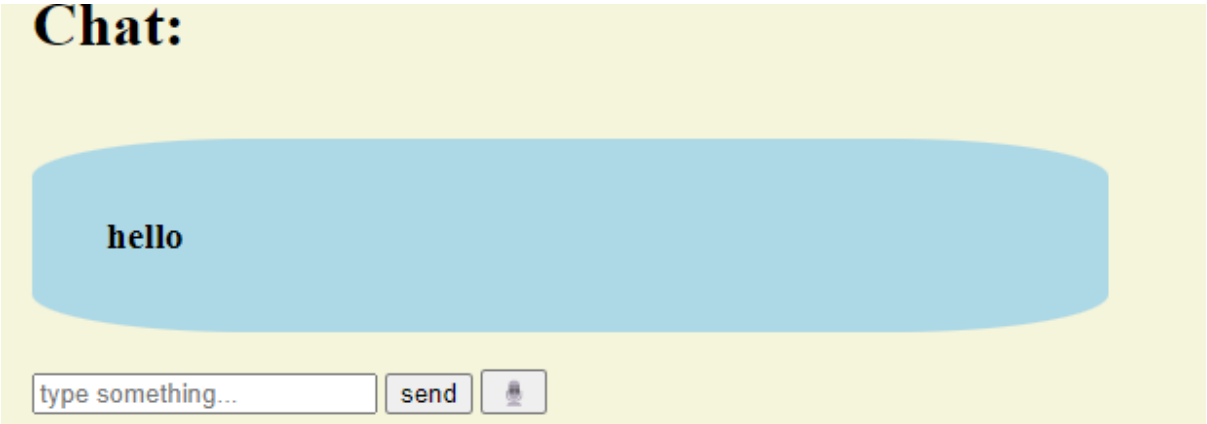
[Figure 6.9 - placeholder fitbit data output]

User Testing:

Participants had reported issues finding the button to gather their fitbit results. Therefore, further adjustments were made to make it clearer for the user. Instead of the button being placed at the bottom, the decision was made to put the button at the top so the user can see where they can gather their fitbit data.

Chat Implementation

This feature was originally going to use socket.io however as this was not of high priority on the list. The other features had taken priority. However, the chat layout had been created.



[Figure 6.10 - chat system output]

The blue speech bubble represents the user. Another colour would have been used to present other users.

The other features had taken priority as creating a chat feature may be increasingly difficult as clients expressed frustrations for using similar chat services with other providers. Furthermore, this may lead to changes of the “Chat” functionality as other alternatives such as voice messaging or calling may also be an option.

Feature status: Incomplete

Authentication Configuration

Authentication was provided via the use of auth0. Auth0 is used to securely provide access to applications for its users. This application makes logging in an optional feature. Auth0 matches access tokens provided by google and if it is not correct the user is unable to use

the application. This makes it easier to log users in without having to worry about data breaches as auth0 handles the authentication of the app.

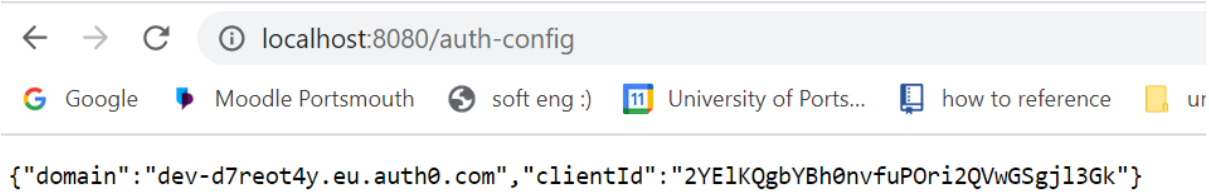
The authentication test was to see if the path route of auth-config would work. Presented down below:

Integration testing:

```
let authConfig = await fetch('http://localhost:8080/auth-config');
await test('Testing authorisation configuration endpoint', async () =>
{
  await expect(authConfig.status).toEqual(200);
});
```

This tests if auth0 returns the configuration details when the following url is typed in

```
http://localhost:8080/auth-config
```



[Figure 6.11 - auth path route output]

This is what is returned when the url is typed in. The unit test should pass due to a 200 code being its status. If the endpoint is broken then this test will fail.

Offline compatibility

The device would be available offline by service workers which save the website whilst offline. This is a crucial aspect of the application if the user is remotely connected.

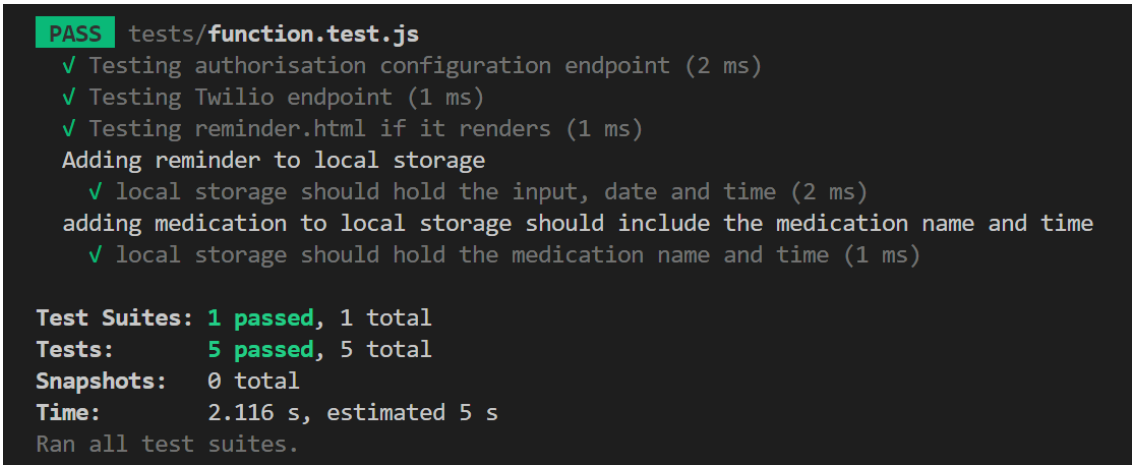
Iteration 1:

```
const CACHE = 'AAL';
const filesHandler = [
  '/index.html',
  '/index.js',
  '/index.css',
  '/worker.js',
  '/offline.js',
  '/manifest.json',
  '/img/elderly-technology.png',
```

```
];
async function fetchFromCache(request) {
  const cache = await caches.open('cacheName');
  const data = await cache.match(request);
  if (data) {
    return data;
  } else {
    console.log('Fetching from network', request.url);
    await cache.add(request);
    return await cache.match(request);
  }
}

function interceptFetch(e) {
  e.respondWith(fetchFromCache(e.request));
}

async function getServiceWorker() {
  try {
    const c = await caches.open(CACHE);
    await c.addAll(filesHandler);
    console.log('Service worker registered');
  } catch (e) {
    console.log('cache failed, sorry ', e);
  }
}

self.addEventListener('install', getServiceWorker);
self.addEventListener('fetch', interceptFetch);

// Kopecky, J., &amp;amp; Boakes, R. (2021, May 27). Portsoc/deadline: A
deadline countdown. GitHub. Retrieved from
https://github.com/portsoc/deadline
```

This was placed in the “notify” branch. Whilst the code did allow for offline usage, problems appeared with the usage due to the inability to log in to the system. There also seemed to be performance issues reported by users. Therefore this will be worked on separately before merging to main to ensure the bugs are cleared before system integration.

Completion status: Semi complete
Integration: pending



[Figure 6.12 - unit test output]

User Testing

User testing was implemented on 5 users aged between 50-70. The user testing feedback was utilised to better improve the applications user experience and to view potential usability problems that were overlooked during the development by myself and the clients. The potential issues will either be implemented as a new increment of development or will be put into future works.

Result of user testing

Task:

You are using an ambient assisted living application. Which helps you during your day to day living. For this task you are required to give your thoughts whilst using the application for the researchers data collection purposes - please speak through what you are doing as this allows the researcher to understand the users thought process to help develop a better application.

You have the application, you are instructed to do the following:

- Log into the application using google
- Create a reminder
    - Pick up the groceries
    - From a week now, at 13:00
        - Any other reminders you want to set
- Listen to all the reminders that you listed

- Press the panic button

- Create a medication reminder of medication that you currently take

(DO NOT PANIC, THE MEDICATION DATA WILL BE REMOVED AS SOON AS THE EXPERIMENT IS OVER)

- Fill in details of the emergency contact

End of experiment

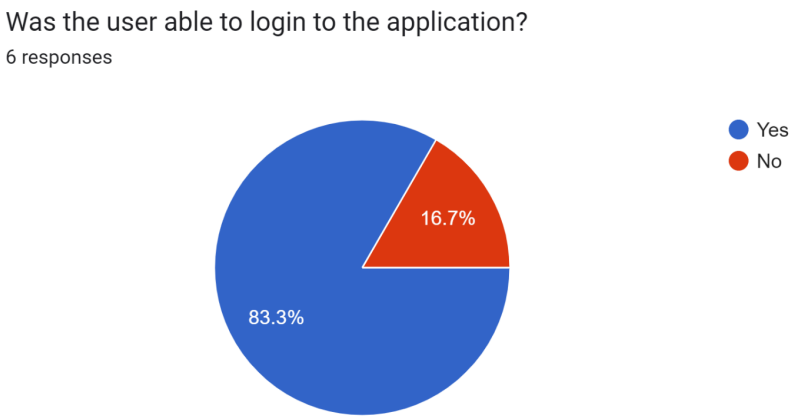
[Figure 6.13 - Task usability testing]

The metric which was used to measure the success of the application was qualitative feedback from the user profile and if they were able to complete the task. The results were gathered via completing a questionnaire and based upon researcher observation. The participant was also given the opportunity to rate the navigation for the application and provide feedback.

The feedback formed was used to improve the overall user experience of the application.

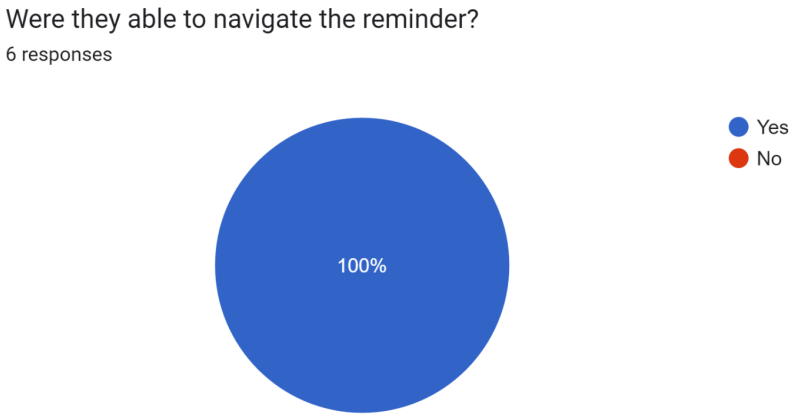
https://github.com/gurvirdhillon/AAL-project

User Testing Evaluation



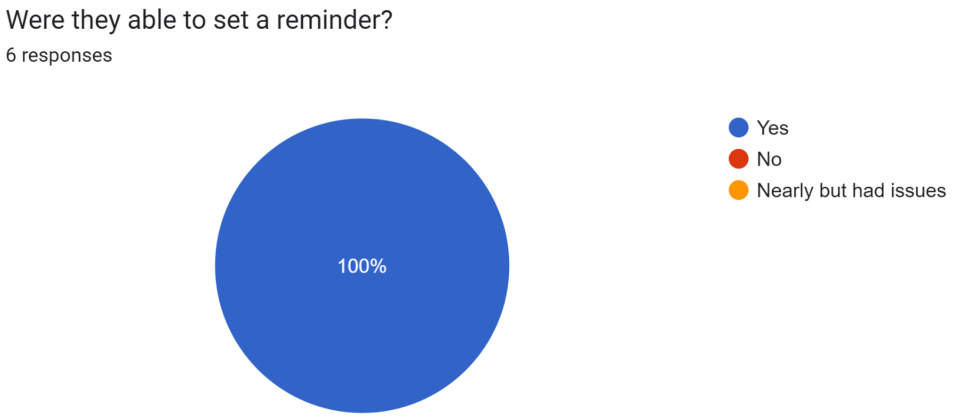
[Figure 6.14 - usability login poll]

From the user testing only 1 participant had not been able to login to the application however this was due to the user interface of auth0 - the participant had explained they were able to locate the login button but they could not login due to an inexperience in using auth0.



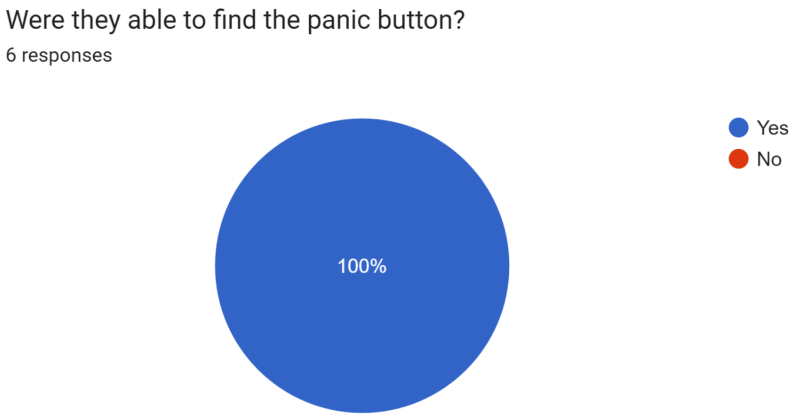
[Figure 6.15 - usability testing reminder navigation poll]

All the participants were able to sufficiently navigate to the reminder section by using the “tabs”.



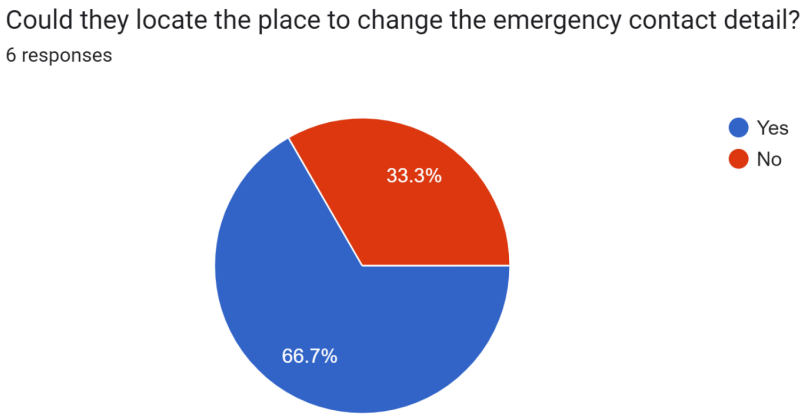
[Figure 6.16 - reminder setting poll]

Furthermore, the users were able to set a reminder with no major problems stopping them from completing their task.



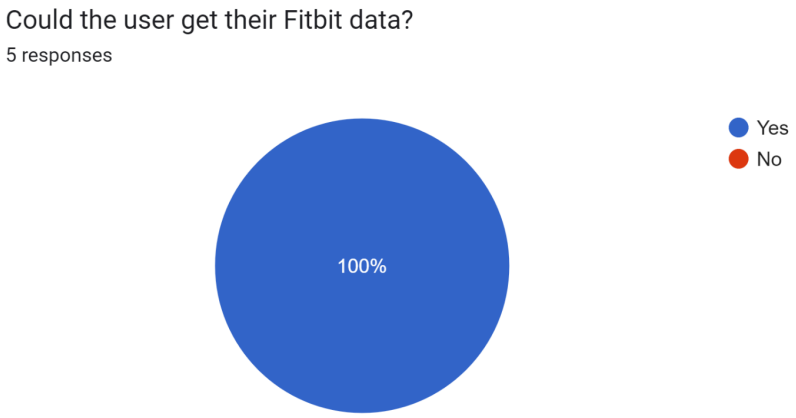
[Figure 6.17 - panic button navigation]

All users could find the panic button and were able to trigger the emergency event that will alert the caregiver. Users reported they had felt a sense of safety from this feature and had reported positive feedback from “checking” before the message was sent.



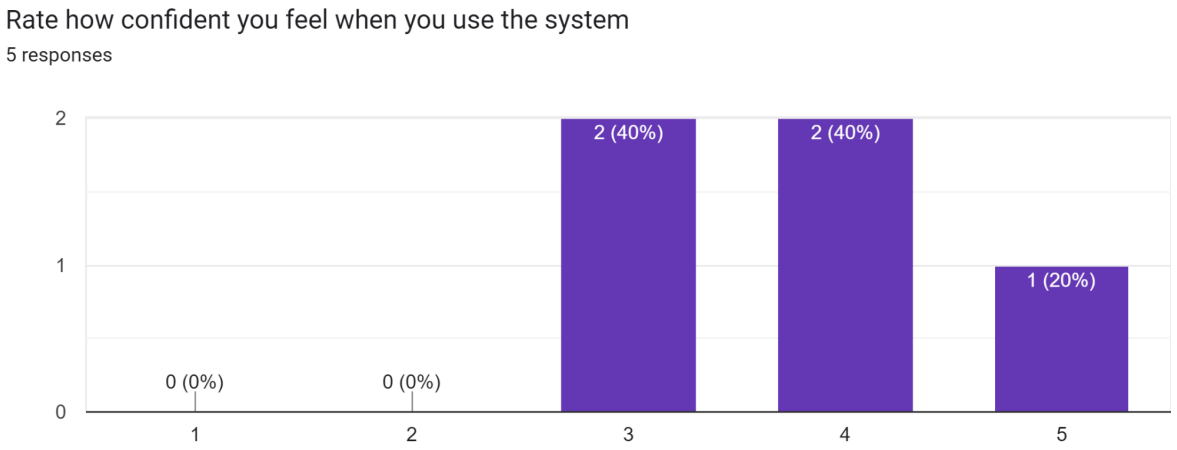
[Figure 6.18 - emergency contact detail]

It was reported that 50% of the users had depended on the use of the search engine for finding the emergency contact which was not available during the user testing stage.



[Figure 6.19 - fitbit data]

The users were able to navigate their physical activity for the day. They had given feedback on the layout and expected a fitbit like layout in the form of widgets and making it bigger to read the statistics.



[Figure 6.20 - system confidence]

The graph shows the overall user confidence level when they use the system. The 1 demonstrates no confidence when using the system, the 5 showing high levels of confidence whilst using the system.

The graph shown above shows a mode of 3 and 4. The standard deviation shows 0.75 which means that the results are clustered around the mean(the mean which is 3.8) therefore all the results are close together. This means that most participants were at a consensus when answering the survey.

Usability Task Limitations

A smaller sample size means that the usability test cannot be representable to the entire demographic as only 6 participants were recruited. Therefore, an increase in the level of bias may impact the results due to a demand in character(users not rating the system accurately as they want to favour the researcher). It can also impact the user results as outliers can cause a variation in the data set.

The sample was collected via convenience sampling therefore this can present further bias as the researcher may present unconscious bias for selecting candidates for those who are readily available.

Chapter 7

Evaluation

This chapter provides a comprehensive overview of the process undertaken, an evaluation of the project and its work completion as well as a reflection on the methodology that was used.

Requirements Evaluation

With further talks from the stakeholders FR002 had not been considered of high importance due to customers finding communication applications via texting to be of great difficulty therefore this would cause many types of usability issues that would need to be addressed within a short time scale which was not possible. However, if this was to be addressed within the future web sockets would be used to allow for collaboration with other people using the application.

Functional requirements

Code	Completion status	Prioritisation	Iteration number
FR001	Complete	Must	3
FR002	Incomplete	Could	1
FR003	Complete	Must	3
FR004	Partially complete	Should	2
FR005	Complete	Should	3

Non-functional requirements

	Completion status	Prioritisation	Iteration number
NFR001	Complete	Must	3
NFR002	Complete	Should	2
NFR003	Partly complete	Could	2
NFR004	Partly complete	Should	2
NFR005	Complete	Must	3

User interface requirements

	Completion status	Prioritisation	Iteration number
UI001	Incomplete/future works	Must	2
UI002	Complete	Should	1
UI003	Complete	Should	3
UI004	Incomplete/future works	Could	2

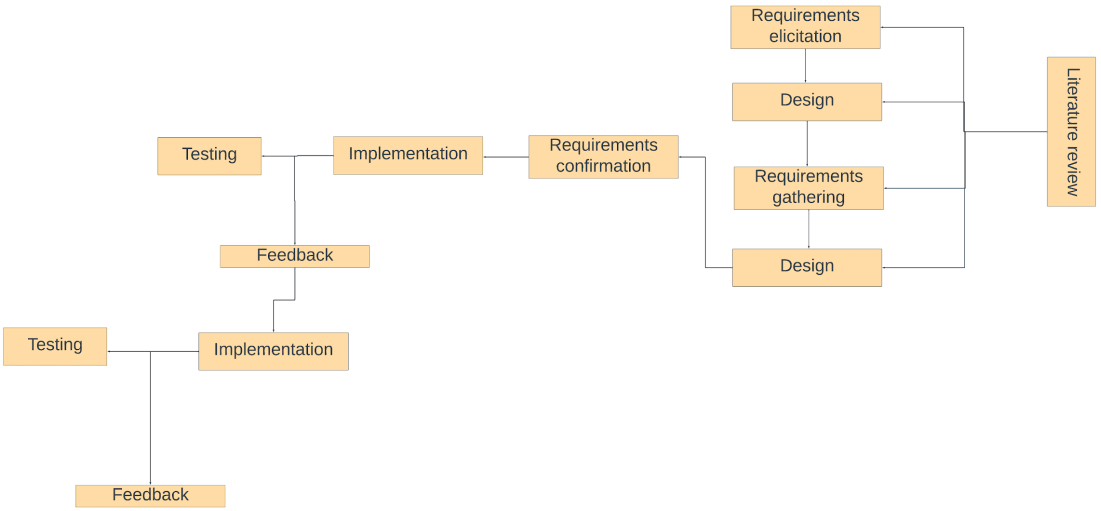
Accessibility requirements

	Completion status	Prioritisation	Iteration number
ACR001	Complete	Must	3
ACR002	Complete	Must	2
ACR003	Complete	Should	3
ACR004	Complete	Should	2
ACR005	Complete	Could	1

Project Management and Planning

The iterative approach had allowed the artefact to develop overtime by building on the previous iteration and from relying on clientele feedback. It has allowed for a better understanding of where further development must be made.

This utilisation of iterative kanban also caused constant changes to be made within GitHub Kanban where the overall changes to the project can be seen visibly. This has supported monitoring whilst the project is currently in the development process.

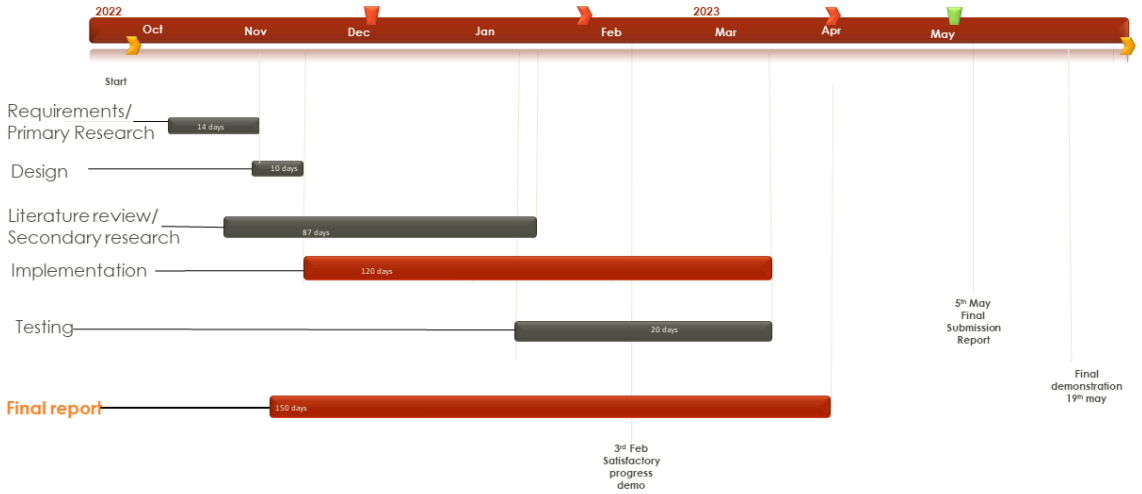


[Figure 7.1]

Time Management

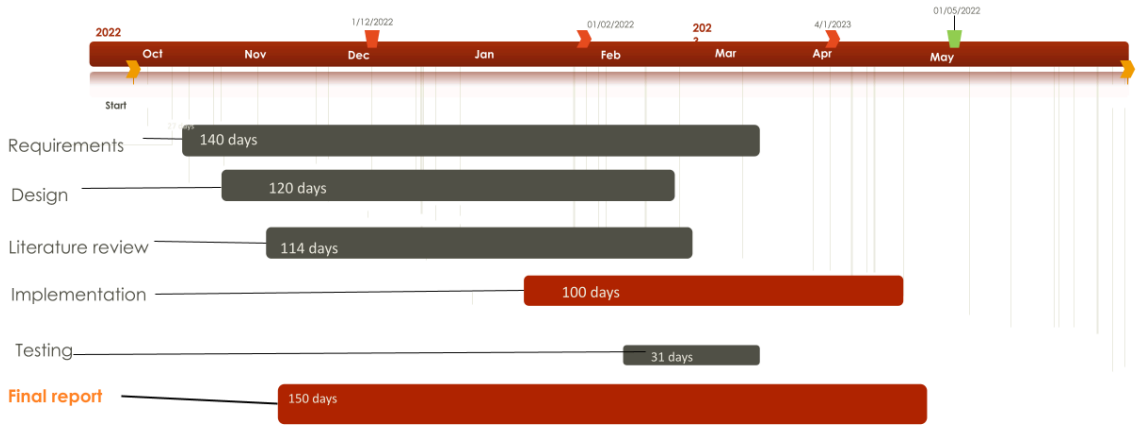
The project plan was not followed as initially expected, with the design chapter taking longer than originally anticipated despite starting earlier than the predicted date. However, the literature review was started and finished on schedule as predicted. Gathering surveys as a method of forming requirements had proven to be difficult, with changes occurring in the original gathering of requirements, a low response rate and participants had to be prompted consistently to complete the survey. Due to the knockover effect of the requirements, this led to a later start date of the project artefact (the implementation section) therefore the first commit was on the 13th January 2023. Furthermore, the decision for the programming language choice was still being chosen based on the stakeholders needs/preferences. Despite the setback, testing was completed ahead of schedule due to the agile development and continuous testing being utilised. The final artefact report (documentation) was written ahead of schedule (the artefact report had taken 120 days to complete which was written whilst implementing the system which had allowed for easier following of the iterations). There were slight disruptions due to ill health which had affected the overall quality of the artefact produced, these risks were aimed to be kept minimal with the use of continuous delivery.

Original Timeline Expectation



[Figure 7.2 - project process expectation]

The Outcome Timeline



[Figure 7.3 - project process outcome]

The requirements were underestimated as the original requirements elicitation strategy was omitted within 20 days of the process. The data gathered from the previous method was scrapped and a new one was created alongside the design phase. The requirements gathering was time-consuming due to the complexity of the finalised elicitation process. The design, requirements and literature review were all done in parallel as this can all help form a design which will better enhance the artefacts user interface as secondary and primary research is being gathered.

The original timeline does not align with the agile approach but instead follows the waterfall methodology. In agile, requirements are gathered and developed synchronously to allow for quick adaptation compared to following a linear approach to development.

Previous Technologies Attempted

Originally the artefact was going to be made using ReactNative. However ReactNative has limited API availability, as it does not provide built-in support for all devices. Therefore, the decision was made to use NodeJS due to its wide support for API use. However, if the system was to be redesigned as solely a mobile application, flutter would be used as it includes features such as hot-reload and intuitive user interface designs.

The choice of using NodeJS was made as it allows for wider availability on the internet. NodeJS supports offline downloadable systems which can run as its own application. This has the ability to use web applications for offline capabilities. This would also support the use of sending messages, gaining data from the fitbit and receiving reminders or medication.

Chapter 8 - Conclusions

Overall Conclusion

The overall goal of this project was to support elderly individuals with their day-to-day activities using website applications. Some features may have limited accessibility as it does not support certain devices such as the apple watch due to financial constraints this was not viable to test out when creating the application.

The applications main aim was to communicate essential information over using the website. This has been achieved through the use of the TwilioAPI when the panic button has been triggered. This has been configured to one device at the moment and will be configured to an emergency contact number in the future.

Other features such as reminders and medication notifications were also created for better user experience, it reminds the user of the date and time of the event. This required the use of the notification API for both features which reminds the user of what they have inputted. Furthermore, users are able to generate placeholder data of their fitbit data which will be developed further to get concurrent real time data to generate.

Limitations to the Application:

The user may require enabling permissions such as notifications and microphone access. Without this the system may not be fully functional. These features cannot be passed through without permissions on the web.

Future Works

The application was solely created for the use of a laptop during its development cycle. However, future works will provide the ability to better access the application using a tablet device using media queries and adjusting the user interface to fit the users needs. According to the stakeholders, they would most likely access the application using a tablet device. Continuous testing will be done on the application when adjustments are made to the user interface and the agile iterative approach will still be utilised in future.

Furthermore, the apple watch will also be a part of the future works as this will create more diversity of users to utilise the activity feature. This has been included as a future requirement as it requires more complexity including the creation of a healthkit enabled application which uses xcode and swift.

At the moment, the Fitbit API requires the auth0 2.0 token to be implemented with an access token and a refresh token. Future works will include using real time data instead of placeholder generated data. This may be particularly useful for the next of kin to see the users activity levels.

Reminders and medication notifications will be improved in the future by sending a message to the user alerting them to take their medication using the TwilioAPI. Furthermore, making this interactive will be necessary such as asking the user if they have taken the medication and they can reply with yes or no.

The database will store reminders for the user with real time notifications being sent to the user as it allows for better maintainability in the future. This is because the website's client can only support a certain amount of traffic when upscaling. This can lead to better reliability in the near future.

Chapter 9:

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"The power of the Web is in its universality. Access by everyone regardless of disability is an essential aspect." - Tim Berners-Lee, W3C Director and inventor of the World Wide Web

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Appendices:
Appendix A: Project Initiation Document

UNIVERSITY OF PORTSMOUTH

School of Computing
Final Year Engineering Project

Project Initiation Document

Gurvir Dhillon

Assisting living for the elderly using mobile applications

1. Basic details

Student name:	Gurvir Dhillon
Draft project title:	Assisted living for the elderly using mobile applications
Course and year:	3rd year Software Engineering(Bsc)
Project supervisor:	Athanasios Paraskelidis
Client organisation:	
Client contact name:	

2. Degree suitability

This project is suited to a software engineering degree as it will focus on the many different facets that a software engineer would face in the real world including usability engineering, database management, software development and maintenance.
Developing this project will allow me to offer a wide range of services to my target audience(the elderly) whilst being aware of the many different accessibility legislations and guidelines a software engineer has to consider on a daily basis.
It will help me look at which database management system would perform the best whilst considering constraints on time, resources and technology. Software maintenance is a crucial aspect as writing code for future developers to work on(if made open source) requires both good documentation and maintainable code.

3. Outline of the project environment and problem to be solved

As society ages, we are choosing to adapt different technologies to help assist the elderly and the vulnerable. There have been many hardware attempts according to my research but as elderly people find it challenging to use technology, researchers are hesitant to use web/mobile applications as its main way of assisting the elderly - in this project I will attempt to make it as easy as possible for the elderly to use software technologies.

4. Project aim and objectives

Aim: To use mobile technologies to assist the elderly with daily living.

Objective: To elicit requirements from my target audience on desired features of the application.

Objective: To follow accessibility requirements and legislations that will aid the elderly user to do their desired task on a device.

Objective: To research a way to communicate data between the sensor and mobile application efficiently.

Objective: To build an application which will communicate between the hardware device and software application.

Objective: Analyse current research and trends into software solutions into ambient assisted living and find areas of development.

5. Project constraints

Constraint	
Time	I have a limited amount of time to develop this application therefore this must be taken into consideration during the development process. So, time management is key. I will ensure I set my own deadlines and deploy code regularly.
Cost/budget	As I am funding the hardware I am restricted to my own budget.
Technologies	As my computer has a limited amount of memory, I must consider the constraints on the computer when creating code and when needed I shall use a server to store any data securely.
Familiarity with technologies	I will be using new technologies therefore my knowledge is limited within mobile and hardware development.

6. Facilities and resources

I will require a Raspberry Pi Sensor to monitor movement within the vicinity of the mobile device. I will facilitate my own funding for the Raspberry Pi device and any further costs. I will be using mainly software applications such as ReactNative in the development of the mobile app. I will be testing this Raspberry Pi and tablet device at home therefore I will not require booking any rooms anywhere at the university allowing me to spend as much time as necessary. I may require a server to host/access the database therefore I will need to use the university's virtual machine.

7. Log of risks

Description	Impact	Mitigation/Avoidance
Time availability	Cannot submit on time	I am aware of how crucial time management is for this project and I will give myself deadlines and follow an agile philosophy throughout the entirety of the process.
Technical difficulties	Cannot produce the expected project deliverables.	I will ensure I start practicing my programming ability for the hardware as soon as possible and will undertake courses to aid my learning.
Unpredictable circumstances (illness, lockdown, etc…)	May not deliver the entirety of the project	I will fill out an ECF if it is illness related and ensure I complete the project to the best of my ability. However, if it is a lockdown(in the very unlikely event), it will not affect my project as much as I can do everything remotely(including the final delivery online).
Availability of resources	Hardware may not be available in the time provided.	As hardware is required, I must purchase this item through external sources. However, I must ensure it is still available before purchasing.
Loss of data	Inputted data into the DBMS is lost. Corruption of files	As I require a database I must ensure that I store the information safely and securely. I should sanitise my database and ensure that I execute code which does not cause SQL injection. Corruption of files can also be a very big issue therefore I will ensure I keep a backup of my work onto a GitHub repository very frequently. This GitHub repository will be made private throughout the project until completion.

8. Project deliverables

For the project I would have to deliver a final report which would consist of information about the artefact I have created. In summary the artefact would include a mobile application and a blind motion detection sensor. For the mobile application it must contain a database which will store the users data, the next of kin and details of the sensor status.

The final report would consist of details such as proof of use cases, designs of the system, transcripts of the interviews and requirements that have been broken down into its key segments(functional, non functional, user etc).

Shown below are my list of all intended items to deliver:

- Requirements elicitation
  - Functional
  - Non functional
  - User requirements
  - System requirements
- Designs of the application
  - A finalised ERD of the database
  - Use case diagrams using UML
  - Sequence models
  - System architecture
- Blind motion detection sensor
- Mobile application
- Final report
  - Literature review
  - Development of the system
  - Testing
  - Evaluation and analysis
  - Conclusions
  - Diagrams
- Ethics form

9. Project approach

How will I manage the process?

I plan to kickstart the process by referring to recorded video conferences of experts in the industry to see their range of solutions and how it works - this is because they will explain the key concepts easier as their audience may not be of the same technical expertise. I will refer to websites and look at commercial solutions and products with their description of the process to see their functionality and the process their solution undertakes. Then I will refer

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to google scholar and read articles and journals from academics to see their findings and research.

Project management style

I plan to manage my process by using a kanban board to better utilise my time efficiently and this will allow me to view where I must dedicate and prioritise my time. GitHub has its own project board which I will utilise throughout the process. I will invite my supervisor as a collaborator and this will let him to monitor my progress.

Software development life cycle(SDLC)

I will ensure I use a software development life cycle as this is required for usability engineering and in ensuring that all user requirements are met. I will deliver my software incrementally where I will deploy each functionality and each part of the system until it meets a satisfactory level.

Primary and secondary research

Before undertaking the project I will conduct secondary research to see the current set of proposed solutions to the issue of ambient assisted living and review the challenges, where areas are needed to develop and how I can improve my artefact using previous research and avoid its pitfalls.

Primary research will be used to gather opinions and feedback of the elderly and their next of kin for the features they would like to see in the application. This will be used with a mixture of surveys and interviews.

GitHub issues to remind myself of bugs

I will ensure once I find any bugs I will create a GitHub issue and assign it to myself to fix, reminding myself of the issue at hand. This will allow me to track bugs, deal with issues easier and check the status of the project.

10. Project plan

The following shows the breakdown of how I will conduct my project.

- I plan on keeping a logbook where I will talk about my findings, any insights that have been made and any important elements. This will be useful ahead of time as I can revisit key bits of information that I may have forgotten previously.
- I will carry out a literature review and conduct secondary research into the current market with their provided solutions and its areas for development.
- Establish the requirements needed for my target audience and what is required of me when designing the artefact.
- Create a mobile application using the elicited features requested and have the blind motion sensor communicate data about motion.
- I will then write my final report based on the research of my literature review, my own primary research conducted(interviews with stakeholders and surveys), secondary research collated and the final artefact created.

- I plan on learning ReactNative. I plan to do online courses to help me learn some of the key concepts. ReactNative was built on Javascript which I have used previously in web development therefore transferring over my knowledge should not be difficult.
- I plan on teaching myself Raspberry Pi using online courses as I require this for the hardware device I will be configuring.

11. Supervisor Meetings

As discussed with my supervisor, we have agreed to a fortnightly meeting(every 2 weeks) for the first teaching block. These meetings will be 1 to 1 and are flexible in the delivery(can be online or face to face depending on the circumstance). In the second teaching block it will be a meeting every week to track my progress. Communication will happen via email. I will also invite him as a collaborator to my GitHub repository where he will be able to overview what has been done currently in real-time.

12. Legal, ethical, professional, social issues (mandatory)

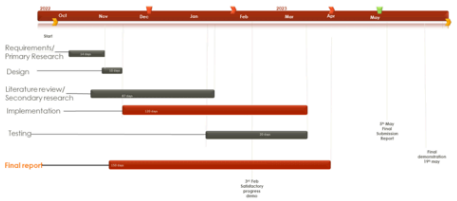
I will need to ensure I am compliant with the Data Protection Act(2018) which states that all personal data gathered must be protected and must only be used when necessary. I will only keep the data for as long as it is necessary. I will ensure all participants will have access to their data stored about them, if the data is incorrect they will have the ability to alter the data and they have the right to erase the data.

I am aware indoor motion-sensors raise an issue of privacy therefore I will make sure all participants are aware of the possible implications on privacy and will make them aware they have a right to leave the project research at any given time. I will ensure that no other data is collated by the motion detector other than movement within the catchment area.

I acknowledge that the sensor may not be highly accurate as it detects any motion. For example, influences such as the wind going through a window may be accounted as motion or when the elderly user's pet moves near it detectors will recognise it as motion. Therefore, this is why it will be considered as an additional feature but not the main artefact.

Appendix A: Ethics certificate

Appendix B: Gantt chart



Requirements:

I will be eliciting the:
- What the user requirements are.
- What the system must offer.
- What functionality is required.
- What the users deems as important non functional requirements.

I will find out my requirements through interviews and surveys as stated previously.
I will be giving out an ethics form before the interview and giving a debrief which will give information about whether they wish to withdraw from the experiment or if they have any further queries/comments about how their data will be handled and their rights.

Design
I plan on creating my design based on the requirements elicited from the target audience.
I will then measure up my design based on the guidelines and accessibility requirements that are enforced by the w3c organisation.

The literature review/secondary research section
- I will first conduct a wider range of research, where I'll find out a basic outline of the topic area.
- Then I will narrow it down in scope, focusing on the specific software solutions that have been proposed. I'll have a look at podcasts, news articles and a number of resources before moving to academic papers(due its complicated terminology that is used hence pre-reading can help understand terminology better).
- Most of my research sources will be from academic articles inside the literature review as this has been delivered by experts in the field of research.

Testing
I will be using Jest as my testing framework for mobile development. I have chosen this as it is supported and maintained by Meta. It is something I have used in the past when developing website applications.

Appendix B: Certificate of ethics form

UNIVERSITY OF PORTSMOUTH

Certificate of Ethics Review

Project title: Assisting living for the elderly using mobile applications

Name:	Gurvir Dhillon	**User ID**:	2016988	**Application date**:	13/10/2022 17:47:48	**ER Number**:	TETHIC-2022-103738

You must download your referral certificate, print a copy and keep it as a record of this review.

The FEC representative(s) for the **School of Computing** is/are **Haythem Nakkas, Dalin Zhou**

It is your responsibility to follow the University Code of Practice on Ethical Standards and any Department/School or professional guidelines in the conduct of your study including relevant guidelines regarding health and safety of researchers including the following:

- University Policy
- Safety on Geological Fieldwork

It is also your responsibility to follow University guidance on Data Protection Policy:

- General guidance for all data protection issues
- University Data Protection Policy

Which school/department do you belong to?: **School of Computing**
What is your primary role at the University?: **Undergraduate Student**
What is the name of the member of staff who is responsible for supervising your project?: **Athanasios Paraskelidis**
Is the study likely to involve human subjects (observation) or participants?: Yes
Will you gather data about people (e.g. socio-economic, clinical, psychological, biological)?: No
Will you gather data from people about some artefact or research question (e.g. opinions, feedback)?: Yes
Will the study involve National Health Service patients or staff?: No
Do human participants/subjects take part in studies without their knowledge/consent at the time, or will deception of any sort be involved? (e.g. covert observation of people, especially if in a non-public place): No
Will you collect or analyse personally identifiable information about anyone or monitor their communications or on-line activities without their explicit consent?: No
Does the study involve participants who are unable to give informed consent or are in a dependent position (e.g. children, people with learning disabilities, unconscious patients, Portsmouth University students)?: No
Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants?: No
Will blood or tissue samples be obtained from participants?: No
Is pain or more than mild discomfort likely to result from the study?: No
Could the study induce psychological stress or anxiety in participants or third parties?: No
Will the study involve prolonged or repetitive testing?: No
Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?: No
Are there risks of significant damage to physical and/or ecological environmental features?: No
Are there risks of significant damage to features of historical or cultural heritage (e.g. impacts of study techniques, taking of samples)?: No
Does the project involve animals in any way?: No
Could the research outputs potentially be harmful to third parties?: No
Could your research/artefact be adapted and be misused?: No
Will your project or project deliverables be relevant to defence, the military, police or other security organisations and/or in addition, could it be used by others to threaten UK security?: No

Supervisor Review

As supervisor, I will ensure that this work will be conducted in an ethical manner in line with the University Ethics Policy.

Supervisor comments: **##supervisorComments##**

Supervisor's Digital Signature: **##supervisorSig##** Date: **##supDate##**

Appendix C:

Ambient assisted living for the elderly using mobile applications

Hello, I am Gurvir Dhillon, a third year undergraduate student studying software engineering. My supervisor is Athanasios Paraskelidis. I am conducting an engineering project which involves using technological solutions to assist the elderly in their homes.
What is Ambient assisted living?
This is a term used to describe monitoring the elderly and providing support using technology as they live independently.
This questionnaire will take 10 minutes of your time and your participation would be greatly appreciated. This questionnaire will not ask for any personal information that can uniquely identify you. You have the right for your data to be removed or altered(GDPR 2016). Your data will be kept by myself(up2016988@myport.ac.uk) and will be removed after the project completion(19-05-2022). You may withdraw from this experiment at any given time. For further questions on how your data will be used please email myself (up2016988@myport.ac.uk) or my supervisor (Athanasios.Paraskelidis@port.ac.uk).

up2016988@myport.ac.uk (not shared) Switch accounts

*Required

Do you consent to data being gathered from this survey? If no, click on the "X" button on top of the tab. *

- ◯ Yes (By clicking yes you provide consent for your data to be used)

Ambient assisted living for the elderly using mobile applications

up2016988@myport.ac.uk (not shared) Switch accounts

*Required

About the User

This data is needed to uncover the demographic of the people who have answered the questions.

What is your age range? *

- 18-24
- 25-34
- 35-44
- 45-54
- 55-64
- 65+

Ambient assisted living for the elderly using mobile applications

up2016988@myport.ac.uk (not shared) Switch accounts

*Required

Experience with ambient assisted living

This section is to see the participants previous experience with ambient assisted living.

Have you used/considered using ambient assisted living technologies? *

- ◯ Yes
- ◯ No

Section 3 of 7

Experience with ambient assisted living

This section is to see the participants previous experience with ambient assisted living.

Have you used/considered using ambient assisted living technologies? *

- ○ Yes
- ○ No

After section 3 Continue to next section

Section 4 of 7

Experience with Ambient assisted living

This section is to see the participants previous experience with ambient assisted living.

If yes, can you describe your experience with using ambient assisted living?

Long-answer text

If yes, can you describe your experience with using ambient assisted living?

Long-answer text

What aspect of your life would you expect to improve by using an ambient assisted living system? *

- [ ] To help monitor how active the user is and encourage more activity if required.
- [ ] Reminding the user of key information(e.g reminding about taking medicine, ordering shopping etc...)
- [ ] Contact a family member in an emergency efficiently
- [ ] To help manage my daily duties.
- [ ] Other...

Which group of people do you think would benefit from the use of ambient assisted living?

- ( ) The elderly
- ( ) Vulnerable users
- ( ) Younger demographic
- ( ) Individuals with physical impairments
- ( ) None of the above
- ( ) Other...

If you decided to use an Ambient Assisted Living system. How much would you be willing to spend on the system? *

- ○ Free
- ○ £1 - £49
- ○ £50 - 99
- ○ £100 - £199
- ○ £200 - 299
- ○ £300+

With the selected budget, what do you expect from the ambient assisted living system? Please select a **maximum of two**. *

- ☐ Assistance with reminders(reminder to take medicine, reminder to order the shopping)
- ☐ Assistance with user activity(detecting if the user is being active)
- ☐ Assistance in emergency(fall detection, panic button etc...)
- ☐ Assistance in entertainment(playing your favourite music, gathering family memories)
- ☐ Other...

Section 5 of 7

Experience with Ambient assisted living

This section is to see the participants previous experience with ambient assisted living.

If no, could you explain why? *

- [ ] I was not aware of ambient assisted living
- [ ] I do not need ambient assisted living
- [ ] Too expensive
- [ ] I did not find it useful for my specific needs
- [ ] I find it difficult to use
- [ ] Other...

What aspect of your life would you expect to improve by using an ambient assisted living system? *

- [ ] To help monitor how active the user is and encourage more activity if required.
- [ ] Reminding the user of key information(e.g reminding about taking medicine, ordering shopping etc...)

What aspect of your life would you expect to improve by using an ambient assisted living system? *

- [ ] To help monitor how active the user is and encourage more activity if required.
- [ ] Reminding the user of key information(e.g reminding about taking medicine, ordering shopping etc...)
- [ ] Contact a family member in an emergency efficiently
- [ ] To help manage my daily duties.
- [ ] Other...

Which group of people do you think would benefit from the use of ambient assisted living?

- ( ) The elderly
- ( ) Vulnerable users
- ( ) Younger demographic
- ( ) Individuals with physical impairments
- ( ) None of the above
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If you decided to use an Ambient Assisted Living system. How much would you be willing to spend on the system? *

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- ○ £50 - 99
- ○ £100 - £199
- ○ £200 - 299
- ○ £300+

With the selected budget, what do you expect from the ambient assisted living system? Please select a **maximum of two**. *

- ☐ Assistance with reminders(reminder to take medicine, reminder to order the shopping)
- ☐ Assistance with user activity(detecting if the user is being active)
- ☐ Assistance in emergency(fall detection, panic button etc...)
- ☐ Assistance in entertainment(playing your favourite music, gathering family memories)
- ☐ Other...

Section 6 of 7

User Requirements

The following section understands more about what the users requires from the ambient assisted living system and their expectations.

For an ambient assisted living system, what do you think would be the most useful way to entertain the user? Please select a **maximum of TWO**. *

- [ ] Prompt me at a specific time feature("App remind me to play Beethoven every Tuesday at 4pm")
- [ ] Contents generator(gathers content the user may like depending on the users interest - i.e sports, favouri...
- [ ] Digital assistant(Siri, Alexa)
- [ ] Other...

What **THREE features** would you expect to assist the health of the user? *

- [ ] Unwell/Panic Button - in the case of an emergency
- [ ] Assistance of medication monitoring("John remember to take your Metformin pills 500g")
- [ ] Feature to track users current health and their symptoms
- [ ] Feature to target user exercise depending on their medication
- [ ] Smartwatch that detects falls
- [ ] Smartwatch that detects the pulse of the user
- [ ] Smartwatch which detects activity of the user and reports it to the app(walking, sitting too much etc)
- [ ] Other...

What feature do you think will help the daily activity of the user(the users usual routine - i.e shopping, calling family, delivering post etc...)? *

- [ ] Reminder feature - notifications("dont forget to meet your daughter at 3pm at cafe")
- [ ] Home/away feature to disallow constant notifications if away(using motion detection)
- [ ] User profile - "John, Diabetic, Arthritis, Needs help remembering to take pills etc"
- [ ] Other...

What **THREE** requirements do you prioritise as the **most important** part for this application? *

- [ ] High performance(quick loading app, fast time to access features etc...)
- [ ] A user friendly system(easy mobile navigation, nice layout,)
- [ ] Reliability(app doesn't crash at random intervals)
- [ ] Security (a secure system which will prevent others from accessing your data)
- [ ] Compatibility with other devices(can work on both android and iOS)
- [ ] How my data is stored/Privacy
- [ ] Accessibility(making it clear to users with low vision)
- [ ] Unsupervised operations(the app works without any input from the user)

Are there any other features you would like to see added to an ambient assisted living app?

Long-answer text

Section 7 of 7

Blind motion detection sensor/additional hardware

A blind motion detection sensor is a sensor which **does not capture footage** but bases detection from motion within a given proximity. For this experiment, I am enquiring on peoples attitudes about blind motion sensors.

Are you open to the idea of having a blind motion detector in your house to assist your day to day living? *

- ( ) Yes
- ( ) No

What is your **number one concern** with having a motion detection sensor in your home? Choose one. *

- ○ Privacy
- ○ Security
- ○ Accuracy of the sensor
- ○ Downtime of the item
- ○ Frequency of the item sending notifications when movement is detected
- ○ All of the above
- ○ None
- ○ Other...

What item would you expect to be most useful to track the activity of the user to ensure that the user is safe? Choose one. *

- ○ Motion detector
- ○ Smart watch monitoring activity
- ○ Smart phone app tracker
- ○ Necklace for activity monitoring
- ○ None of the above
- ○ Other...