IMPROVING LIFE QUALITY FOR ELDERLY AND DISABLED PEOPLE USING SMART HEALTHCARE DEVICES

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A thesis submitted in fulfilment of the requirements for the award of the degree of Bachelor of Computer Science (Computer Network & Security)

School of Computing

Faculty of Engineering

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JULY 2024

DECLARATION

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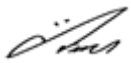
Signature : .....  .....

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DEDICATION

This thesis is dedicated to my father, who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, who taught me that even the largest task can be accomplished if it is done one step at a time, also to my beloved wife, who supported me to continue my studies. I love you all.

ACKNOWLEDGEMENT

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My fellow student should also be recognized for their support. My sincere appreciation also extends to all my colleagues and others who have provided assistance at various occasions. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space. I am grateful to all my family member.

ABSTRACT

The purpose of this study is to explore the potential benefits of utilizing smart healthcare technology for promoting the quality of life for elderly and disabled individuals. This research focus on the ability of smart healthcare technology to improve comfort and reduce healthcare costs for the elderly population. The methodology used in the study includes conducting a survey to gather data on perceptions and preferences regarding the use of smart healthcare devices. The process starts with conducting several case studies to better understand the existing system and its issues. There are several methodologies used for system development, it will analyze and determine the best possible methodology for the system development. Then started designing the basics of the system for better understanding. The overall implementation which takes place in FYP2 is conducted after all aspects of the problem is considered. The main goal is to provide a smart healthcare system that can measure the vital of the user (elderly or disabled people) and upload the gathered data on a server to make the caregiver monitor the user and take an action in case of emergencies. The results of the study indicate that there is significant support for the use of such technology in order to improve the quality of life and reduce healthcare costs for elderly individuals. This research is of particular significance in the context of Kurdistan of Iraq, where there is currently a lack of interest in developing smart healthcare systems. This system will be implemented using IoT technology, by using health care sensors like heartbeat sensor, ECG, body temperature sensor, and blood pressure sensor, all the sensors will be connected to a microcontroller to allow the programming and the networking part of the system.

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LIST OF ABBREVIATION

IOT	-	Internet of things
IDE	-	Integrated development environment
ECG	-	Electrocardiography
UTAUT	-	Unified theory of acceptance and use of technology
UI	-	User Interface
XP	-	Extreme programming
UML	-	Unified Modeling Language
BP	-	Blood pressure
HB	-	Heartbeat

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Elderly people are an important part of the world's population, by looking at the statics, it shows that the number of elderly people is increasing significantly due to many reasons, one of the reasons is the decreased rate of women's fertility around the world. In the United States, the percentage of elderly people over 65 years has increased from 12.4% to 13.3% from 2000 to 2011, and it's expected to reach 21% of the total United States population by 2040 [1]. Based on a United Nations report [2], life expectancy will increase to 83 years in 2045. Most elderly people need regular assistance to accomplish their daily tasks and take care of their health, which most of the time is supported by their family and friends or volunteers [3]. On the other hand, nearly one billion people have some kind of disability in the world [4]. Also, the World Population Ageing reported that 35% of elderly people above 65 had some type of disability that needed special assistance to meet their daily needs [1]. In this era of technology and the internet, the term "Internet of Things" (IOT) has gained attention from all consumer people around the world. Most of internet users are eager to use this new technology and connect their devices to the internet to turn them into smart devices, nowadays, most of the devices can be controlled remotely, for instance, washing machines, TVs, air conditioners, and more devices, using a variety of smart devices with the help of sensors and actuators, houses can be automated to do most of the tasks for us, therefore, why not turn healthcare devices into smart systems that allow remote health monitoring inside our smart houses, which allows elderly and disabled people to remain in their houses instead of regularly visiting hospitals and spending a large amount of money, which most of the time not affordable for most people around the world. Smart healthcare system can be considered as a way to reduce the elderly's healthcare costs, along with many other beneficial purposes that help to promote the elderly's life [6].

1.2 Problem background

Based on the World Health Organization report, one of the most fatal diseases in the world is cardiovascular disease [7]. Also, the number of people who are at risk of getting diabetes is increasing dramatically and is expected to be the seventh cause of death in 2030 [8]. On the other hand, the bad air quality inside the cities is causing many health problems such as asthma and lung diseases. There are around 230 million people suffering from asthma around the world, and over 300,000 people died from asthma in 2015 [9]. People with these diseases need to have their health checked regularly and need medical help right away in case of an emergency. The number of deaths in these situations can be reduced if medical help gets there quickly.

Frail older people like to live on their own and take care of their own homes because it gives them a sense of independence and makes them less likely to feel depressed [10]. But in that case, attending medical centers or being supervised by nurses at home will be an expensive thing for many elderly and disabled people.

Moving around their homes and performing simple activities will be physically difficult for the elderly, especially those with disabilities [11]. For instance, opening or closing curtains, turning on or off the lights, opening doors, calling for help in case of emergencies, and many more uncountable activities that require physical movement to do.

Remotely monitoring elderly's health would be the best solution for many problems that face elderly people during their lives in their homes. A smart device can provide an improved quality of life along with comfort, a constant health monitoring system.

1.3 Project aim

The main purpose of this project is to provide a monitoring healthcare system for elderly people and for those who have disabilities, along with providing a better

quality of life, which can be achieved through using some sensors and smart devices with the help of an application designed for that purpose. The smart healthcare system can reduce the cost of personal aid assistance at home instead of attending hospitals regularly or having a nurse at home. On the other hand, smart healthcare system can alert care givers and doctors in case of emergency.

1.4 Objectives

a) To analyze previous research on the impact of smart healthcare devices on the quality of life of the elderly.

b) To test heartbeat sensor, blood pressure sensor, and body temperature sensor impact on improving elderly health quality.

c) To design an application that can read the data uploaded by the medical sensors.

d) To test the effectivity the smart medical devices in improving the quality of life for elderly and disabled people.

1.5 Scope

a) This project is targeting people who need special care in their lives, like the elderly and people with disabilities.

b) To view the data uploaded by the medical sensors on the designed application, the sensors need to be connected to the internet, as well as the smart device that hosts the application.

c) The smart medical sensors are very sensitive devices that need to be installed and aligned precisely to function properly.

d) For people with multiple disabilities, like deafness and blindness, the system may need to add another kind of alarm, for instance, vibration feedback.

1.6 Importance of the project

The elderly people’s ratio is significantly increasing, especially in those countries that have a good healthcare system. With the increasing ration comes the need to take care of those elderly people, in particular those who have disabilities and cannot do some simple physical activities. The Smart healthcare concept is viewed as a particularly promising way to increase elderly and disabled individuals' access to home care. Smart healthcare system allow elderly people to live in their own homes for as long as they can care for themselves which leads to increase their live quality.

1.7 Report organization

This chapter introduces the proposed project, including the introduction, problem context, project goal, objective, scope, justification, and importance. In Chapter 2, an overview of existing real estate application and system literature is offered. This chapter also contains an examination of the current system in Kurdistan, as well as a comparison between the existing system and the proposed system, technology, and tools, followed by a discussion of the survey's methodology, results, and analysis. In Chapter 3, the system development approach and the software and hardware requirements for the creation of the Real Estate Application are covered. In Chapter 4, the application's system architecture is described. The fifth chapter covers the project's conclusion, which includes a summary of PSM 1's achievements and a description of PSM2's planning and implementation.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There have been a great number of studies done on the influence that smart healthcare technology has had, both positively and negatively, on the lives and healthcare of persons who are old or have impairments. This chapter will examine some of the studies that have had the most effect on the field, as well as compare several real-world applications and systems, both in Kurdistan and elsewhere in the globe, to show the benefits and drawbacks associated with each one. In conclusion, also will view and discuss the results of the survey performed on this topic in the Kurdistan area. Case Studies

2.2 Case Study 1

In this article [12], Ahmed explains, while people with no disabilities have the greatest share of using smart homes, elderly and disabled people are the actual beneficiaries of using the smart home system. Those with disabilities who have nonfunctional or partially functional body parts can greatly benefit from smart homes, and the reason behind that is that the ability to control the home equipment with a simple gesture or a smart device could be of enormous assistance to persons with physical difficulties. Intelligent technology can also assist in monitoring disabled individuals remotely from any location, thereby eliminating the need to assign nurses or any other type of caregiver.

Furthermore, the writer explains that there are many challenges in the way of achieving a robust system like a smart home, for instance, financial, technical, and

psychological challenges. Those challenges will vary based on the person who will use the smart home, which can be a broad matter to discuss.

As a result of the study, Ahmed says that the smart home concept is not new anymore, but the technology didn’t meet the users' demand, especially in developing countries. He continues by arguing that the study shows that smart homes could be the best approach to helping people with disabilities, but many challenges like the way of implementation and the cost are in the way of achieving the desired results, and the smart house technology should become more of a need rather than a costly luxury. Lastly, the author finishes by demonstrating the importance of the smart house concept and how it could be life-changing for many disabled people by improving their quality of life and their healthcare system.

In brief, the article focused on the importance of the smart home system in the lives of disabled people and how it can positively impact them and change the way they interact with their living environment. It also showed the constraints that faced the researchers in developing the best concept that covered all the aspects of a perfect smart house for disabled people; the author focused more on the implementation cost in developed countries and how the cost can be an obstacle. Lastly, the author mentioned that the need of coordination between the public sector and housing authorities, as well as proper measures to promote the smart house concept.

2.3 Case Study 2

This article [13] demonstrates the influence of smart houses on the quality of life of elderly people. The author, Pal, says he has identified over 4,500 articles related to the relationship between smart houses and elderly people, 31 of which met the purpose of this article. Moreover, the findings of this article show that elderly people have a positive attitude toward the concept of smart houses for healthcare purposes, but on the other hand, they show a lot of concern toward the privacy and security provided by these smart houses. This article analyzes two main questions: first, what is the influence of the smart house on elderly people, and second, what are the

challenges and modifications that need to be applied to existing smart houses to fit a specific case?

As indicated by this study, five different dimensions have a direct impact on the quality of life of the elderly living in a smart house; the identified dimensions are: social communication, environment monitoring, health monitoring, recreation and entertainment, and providing companionship. Moreover, about the health monitoring in the smart house, Pal says, a lot of research has been done on this matter, most of it to monitor elderly people with chronic diseases, and the researchers focused on reducing loneliness feeling and social isolation among elderly people [14]. The use of smart houses increased the safety feeling and also helped the elderly people remember their daily tasks and depend on themselves again, which leads to an improvement in their overall quality of life [15]. Regarding the environmental monitoring aspect, the author discusses how can monitor the house environment using sensors and actuators. The benefits of these devices are not only for the elderly in the house; they are for all the residents, but those devices can be very useful for the elders in case of a medical emergency; yet, the effect of those devices on elderly people is not clear [16].

As a result of the study, the author wanted to answer the two main questions mentioned earlier. The answer to the first question based on this study is that smart houses have a positive effect that somehow improves the quality of life for elderly people, but this result cannot generalized. Pal says that because most of the studies were performed with very few elderly people or actors [17], on the other hand, most of the studies were held in countries where the standard of living is high, like the USA and EU, and Pal finished answering the first question by saying that the cost of implementing this technology can be an issue for many countries. More about the second question: Pal says that commercializing smart homes for improving the quality of life of the elderly needs more time, more research, and more development, and the reason for this is that many of the studies are done in an artificial and laboratory environment, which doesn’t represent real-life cases and actual system implementation.

In the conclusion of the paper, the author agreed that smart houses somehow improve the quality of life for the elderly; however, apart from healthcare systems, more areas of the smart house system need more research, and more aspects should be targeted, for instance, social companionship, recreational activities, privacy, and security.

In brief, this paper showed us the importance of the smart house in many aspects of life for the elderly and young people. Many aspects have been discussed, as well as the effect of each aspect in the smart house. The study focused more on healthcare and environmental monitoring and answered two important questions. In conclusion, more researches needed that involves real elderly people to have more accurate results that can be implemented in real life.

2.4 Case Study 3

In this article [18], the author argues about the increasing age of people, the increasing need for medical healthcare associated with this increase in health, and the role of the technology of the Internet of Things (IoT) in this equation. The adaptation rate of smart homes is very low, the author said, and the reason for that is the subconscious caution of elderly people towards new technologies [19–20]. This study is trying to answer two important questions related to the interaction between smart homes and older people. The first question is: what are the factors, and under which model do the elderly accept smart homes in a health context? Secondly, how does this model function in an empirical setting? The author added that it’s a challenge to understand the elderly's behavior toward smart houses because it’s still not on a commercial scale, which leads to a lack of conceptual approach toward accepting any model presented rather than the user perspective. Lastly, this study will use a conceptual viewpoint to view the factors that affect the elderly acceptance of smart homes.

Furthermore, the author explains why the adoption of smart homes is quite low and says this is due to a lack of a holistic approach toward smart homes, especially for

healthcare purposes. Also, most of the research focuses on the devices and the services they provide rather than on the characteristics of the elderly and their social background, which leads to a gap between the user and the available service. [21, 22-24]

Lastly, the author claims that this is the first empirical study that determines how much elderly people are willing to use the healthcare services of a smart house and to achieve that, the researcher used the unified theory of acceptance and use of technology (UTAUT) acceptance model. One of the limitations faced by the research team was the lack of available commercial-scale smart houses for healthcare, as well as the geographical distribution of the elderly subjects; because all of them were from Asia that created a limitation in opinions from the rest of the world.

2.5 Current System Analysis in Kurdistan

In Kurdistan region, three companies offer smart home services, below table (Table 1) will show the companies descriptions:

Table. 2-1. Companies Provide Smart-home Systems in Kurdistan

Company	**Address, Email, and Website**	**Services**
Telehome	Sulaymaniyah, Salim Street, Baxtiyari Email: Info@telehome.me Website: Smart Home | Telehome	• Intercom and smart doors • Smart lighting • Audio system • Security system • Home cinema

High Smart	Sulaymaniyah: Rand Gallery, 6th Floor, Office #06. Email: info@hi-smart.co Website: High Smart (hi-smart.co)	Providing home automation services, more specifically, controlling the smart house using mobile application remotely, and voice controlling the house (lighting and security)
MOF	Sulaymaniyah, House NO. A1-345, New Chwarchra Email: info@mof-eng.com Website: MOF (mof-eng.com)	• Home security • Smart garden • Fire alarm • Solar energy system

As shown in the table above, none of the companies located in Kurdistan region are offering smart healthcare systems for their clients, which indicates a gap in one of the most important systems in the smart house (the healthcare system), and thus the need to implement this system in Kurdistan region is highly recommended to fill this gap.

2.6 Current System Analysis in General

Guangzhou Video-Star Intelligent Corp (GVS®), established in 1999, this Chinese corporation is offering Smart Security, Smart Building, Smart Home and Smart Medical Care services to its clients. On the basis of computer network and Internet technologies, the GVS Smart Ageing System merges its intercom, monitoring, smart home, care, cloud platform, and App products to build a system for the elderly, children, neighbors, and third-party service providers. The shared platform enables the elderly to live with greater independence. In addition to institutionalized retirement,

home-based care, and community daily support, the system includes medical rehabilitation services to accommodate the different requirement of seniors.

As mentioned, the corporation work in many fields, the focus will be on the Smart Elderly Care field in this review. The services offered in this field are:

- Safety Care: various forms of care devices monitor the elderly's activities and transmit the data to their children or caretakers in order to provide them with an autonomous and pleasant living environment. The intelligent retirement system is provided with a single-button call for assistance in the case of an emergency. Through the system's backdrop, the request for assistance information will be given back to the mobile terminal, mobile phone, computer, and other mobile terminals, making it easier for children and staff to discover and rescue immediately.
- Intelligent positioning: when the elderly are out, they may access their real-time location at any moment, prevent them from being lost, or offer prompt instructions about how to handle the alert.
- Comfortable environment: along with the GVS smart home control system, it offers the elderly additional convenience and comfort.
- Family interaction / warm neighborhood: the elderly can contact their children and friends with ease. It is also handy for caretakers or children to care for the elderly and enhance the beauty and warmth of their later years. To safeguard the physical and emotional health of the elderly, the neighborhood offers countless opportunities for enjoyment.
- Health management: may also be connected to third-party devices or third-party cloud health data, such as ECG, blood pressure, blood oxygen, blood sugar, weight and BMI, body temperature, heart rate, lung function parameters, and users can easily see information in a variety of ways. The health data collected by a third-party health collection device can be transferred to the extension and the child's mobile application over the cloud.

The system provided by GVS is covering most of the necessary aspect of elderly health care system, but still, there are missing information about the cost of the system and the privacy of the users which are a very necessary elements in any smart home system in the world.

2.7 Reviewing Similar System

LADD

Living Arrangements for the Developmentally Disabled (LADD) was founded on 1975 by parents who had a son or daughter with a developmental disability. LADD started by providing educational and residential programs, the aim of these programs was to provide educational environment to people with disabilities. Now, LADD is providing a housing support by providing smart houses to assist young and elderly people with disabilities to develop their independence and live successfully in the community using the smart house technologies. In terms of healthcare, the provided smart house will monitor the person sleep patterns, Early Detection Screen for Dementia, smart scale to record vital health statistics, remote support touchscreen to provide assistance by experts, and automated medicine dispenser.

Quill

Quil is a home smart system designed to monitor elderly people at their houses by installing sensors that tracks the elderly movement patterns, this system will record the elderly movement and send it to a device called “The Hub”, this device will analyze the data received by the sensors to detect any abnormality in the elderly movement, also, with the help of Apple smart watches, the system will track the user position and health data like heartbeat rate and oxygen level. The user can buy an extra device called “Don’t Panic Button” which allows the user to call for help in case of emergencies.

Tiga Helthcare

Tiga healthcare is a company established on 2007, the company provides many healthcare services using new technologies. Tiga introduce a system called "CLOSER", this system is a device that turn any house into a smart home care system for elderly people. Basically, the system helps elderly people age in their place while their caregivers can monitor their motion inside the house using Wi-Fi signals, the system will save the routines of the elderly and record the moving habits inside the house, when the system detects an anomaly in the elderly's movement it will automatically send alerts to the caregivers.

2.8 Comparison between Existing System

Table 2-2: existing healthcare systems comparison

Systems / **Features**	**LADD**	**Quil**	**Tiga Healthcare**	**NextPhase**
Deployment and Technology	Inside the house, interactive screen	Zigbee used for the connection with the sensors. GSM used for sending notification	Company servers will transfer the important data to the care giver in case of emergency	Real-time data monitoring over the network using multi platforms (Android, IOS, Windows)
Wearable Device	No	Only Apple watch supported (inside the house)	No	Wearable health vital monitoring
Work area	Inside the house only	Inside the house only	Inside the house only	Limited to the wearable device outside the house, and

				all the functions inside the house.
Connectivity	Online	GSM	Online	Online
Medicine time reminder	Yes, manually by LADD support team	No	No	Automated. Modified by the caregiver.
Healthcare functions	1- Sleep monitor 2- vital health monitor using smart scale 3- medicine dispenser (LADD team) 4- Dementia early detection 5- remote support by LADD team 6- emergency button limited to interactive screen	1- movement detection 2- send emergency message when anomaly movement detected 3- monitor vital health data (user only) 4- Don't Panic Button device used for calling emergency (sold separately)	1- movement detection 2- send emergency notification to the company server in case of emergency like falling or abnormal movement	1- real time health monitoring using wearable devices 2- emergency button using wearables or smart devices 3- send notifications to caregiver or nurses in case of emergency

2.9 Literature Review of Technology Used

This section addresses the technologies for the development of the NextPhase System, some of which are as follows:

2.9.1 Front End Technologies

a) Flutter: Flutter is an open-source UI software development kit created by Google. Will used to develop cross-platform applications for Android, iOS, Linux, macOS, Windows, Google Fuchsia, and the web from a single codebase to control our devices.
b) Arduino IDE: The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. This IDE will be used to control the sensors and actuators used in the project.

2.9.2 Back-End Technologies

a) Firebase Server: Firebase Hosting is production-grade web content hosting server for developers provided by Google. This service used to host the project data and application to make it accessible everywhere.

2.10 The Method Used

There are two methods for collecting data, qualitative and quantitative. Quantitative research use statistics and graphics. It is utilized to test or confirm concepts and hypotheses. Quantitative research evaluates people's actions, views, attitudes, and other traits to develop broad generalizations from a larger sample. Quantifiable data are used to convey facts and discover trends in quantitative research. Utilizing statistical and mathematical tools, the outcomes of this sort of research are determined. Quantitative data will be utilized to assess the cause and prevalence of an issue by attempting to quantify its impacts on a bigger population. This method comprises online, print, mobile, and kiosk surveys; online polls; systematic observations; face-to-face interviews, telephone interviews, etc. Documentation of qualitative research is in writing. It is utilized to comprehend thoughts, ideas, and emotions. The emphasis of qualitative research is words and their meanings. This form of study helps you to learn more about topics you know nothing about. Because a

survey sample is provided with a list of closed or multiple-choice questions, I selected quantitative research (online, in person, or over the phone).

Survey is a quantitative research method. Utilizing a survey, data for the Volunteering Opportunities System were collected. In addition, numerous critical interview questions centered on the beneficial benefits of volunteer work on the future professions of students, as well as all of the challenges Kurdistan would encounter. Importantly, the focused on how the system might assist students. The interview procedure is likewise structured as a funnel since it permits the detection of defects and problems. I picked a survey because it is a sort of data gathering tool used to gather information about individuals. A survey may be designed to collect factual information about individuals or to obtain the views of survey respondents. Online survey research is currently one of the most popular survey research methods. In addition, I choose MonkeyServey since SurveyMonkey is one of the most widely used online survey platforms. The website is incredibly user-friendly, with an abundance of templates and choices that expedite the survey creation process.

Sampling is an approach for statistical inference and estimate involving the selection of individuals or a subset of the population. In addition to saving time and money, it is an essential component of any research plan. For best derivation, research survey software might leverage sampling techniques. This strategy will save money and expedite the collecting of data. The survey was shared on social media channels including Facebook, Instagram, and WhatsApp. This investigation will employ an approach that streamlines the facilities. There are two types of sampling available: probability sampling and non-probability sampling. The non-probability method is a sampling strategy in which feedback is received based on the sample selection skills of a researcher or statistician, as opposed to a predetermined selection procedure. Generally, the findings of a survey done using a no probable sample are skewed and may not accurately represent the intended demographic. However, there are circumstances in which non-probability sampling is far superior to probability sampling, such as during the preliminary stages of a study or while doing research on a limited budget. Non-probability sampling is a convincing sampling technique that

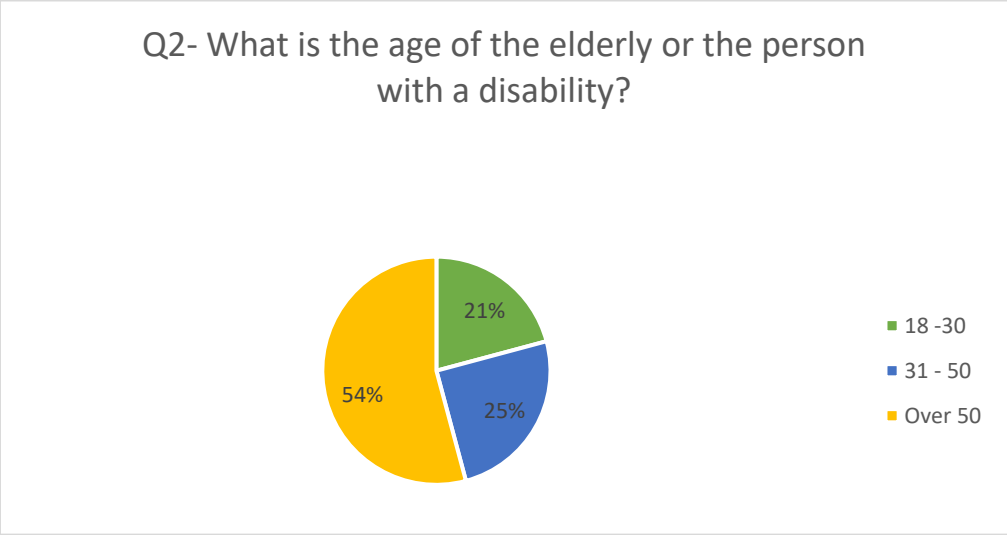
enables us to pick users based on our experience. The survey's target demographic consisted of graduates and organization workers.

2.11 Result and Analysis of the Survey

The survey targeted people who are taking care or have an elderly or disabled person in their house or know someone who are taking care of an elderly person or a person with any kind of disability.

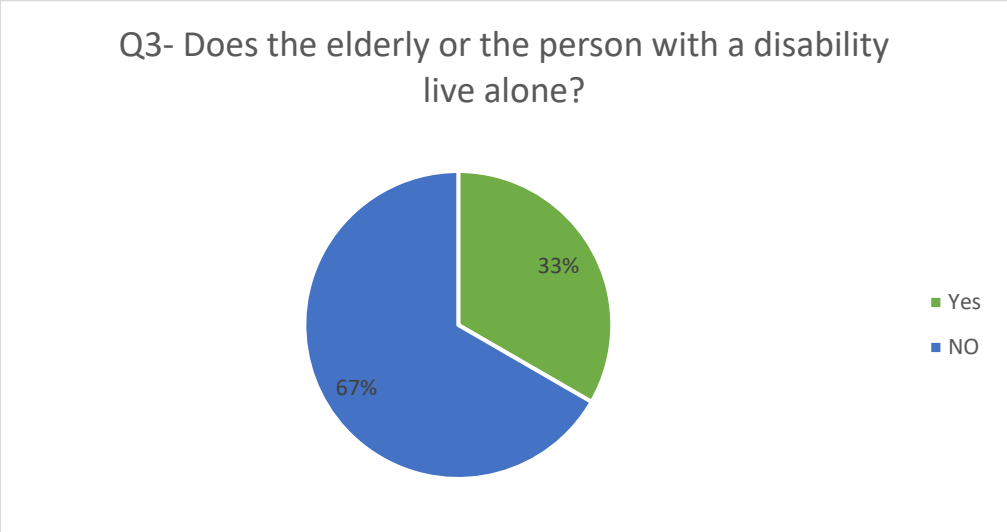
The google questionnaire form consist of 12 questions translated to two other languages (Arabic and Kurdish) to target more audience and collect more samples, the first question is to make sure if the person who takes the questionnaire is eligible for taking this survey, for the list of the rest of the question (Check appendixes)

Question 2:



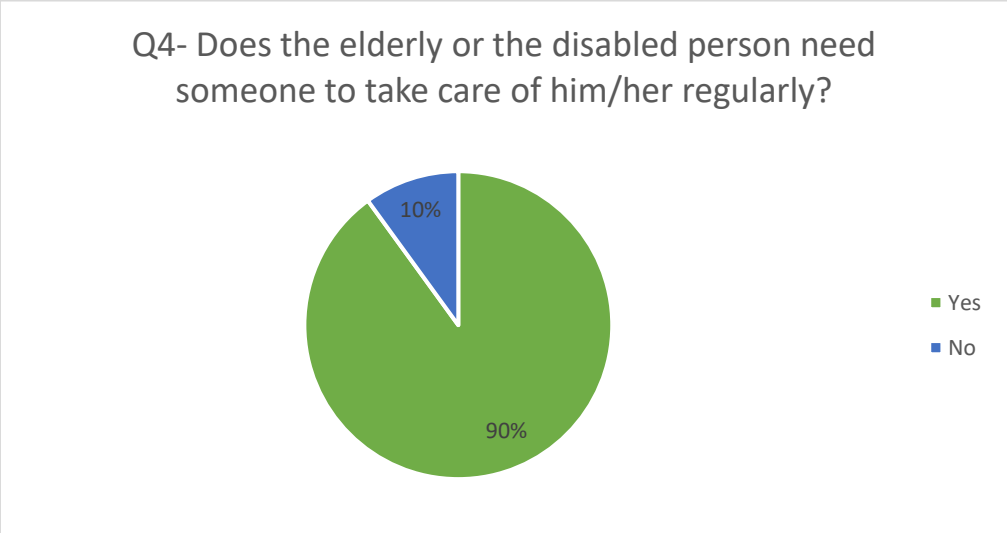
Results of the (Q2) survey shows that 46% of the participants their age ranged from 18 to 50, this age doesn't considered as elderly, but they are disabled people, the and rest are elderly's. Both of those categories are considered our target in this survey.

Question 3



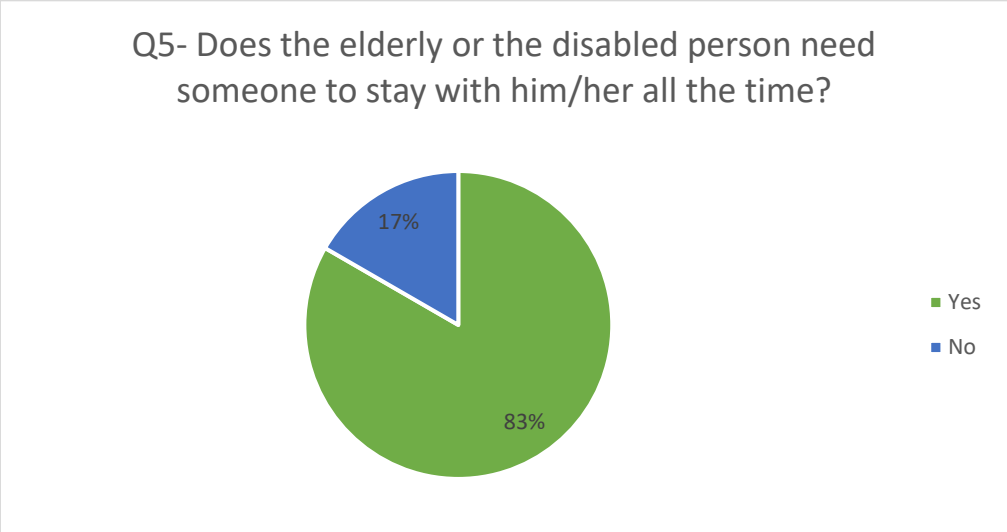
Results of (Q3) show that 67% of the participant don't live alone in their houses, but there are 33% who are living alone, and those are our targeted people.

Question 4



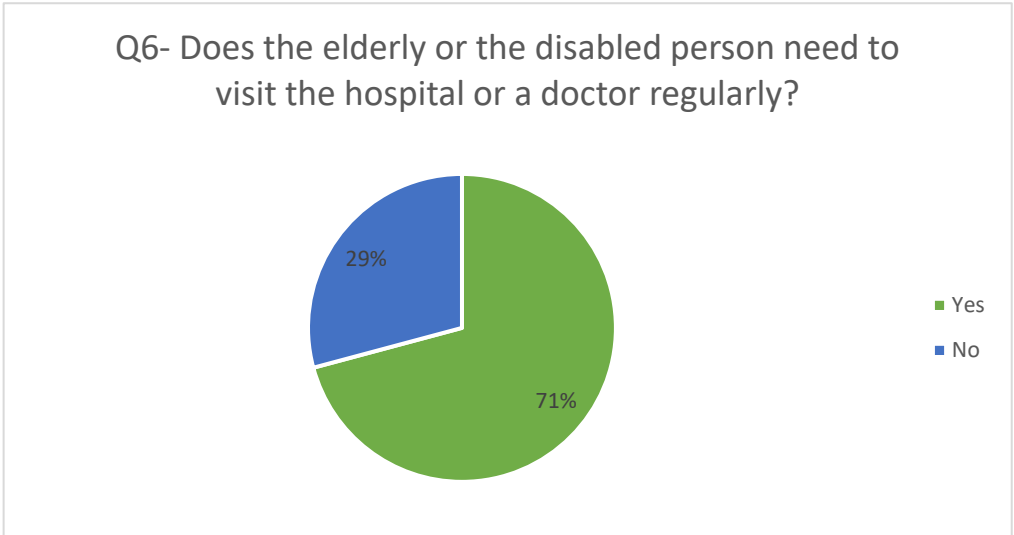
Results of (Q4) shows significant high ratio of elderly and disabled people who needs someone to take care of them regularly. Those persons can be the most beneficiaries of our healthcare system.

Question 5



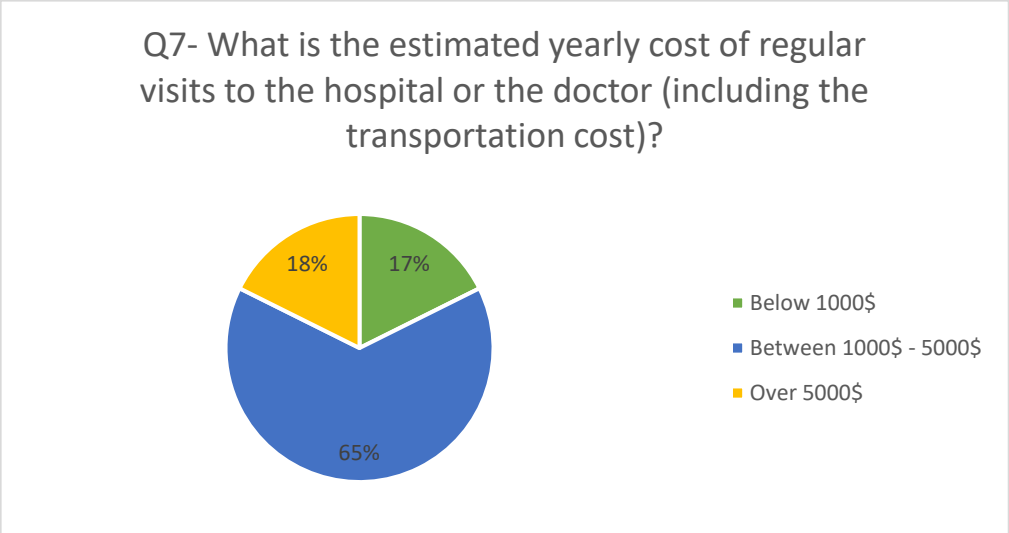
Result of question (5) shows that most of elders or disabled persons need someone to stay with them all the time, which means they can use our system to monitor those persons without the need of physically staying with them.

Question 6



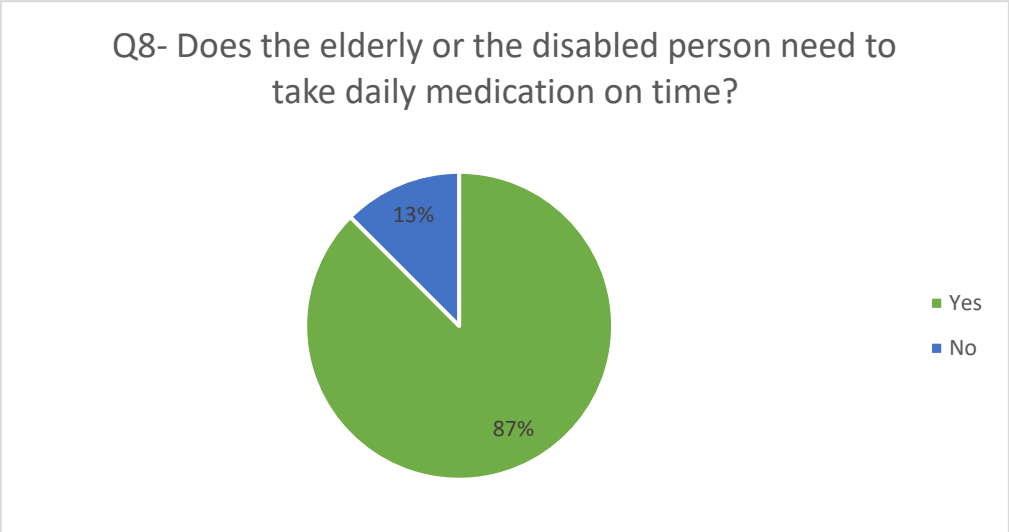
Result of question (6) shows that most of the elderly or disabled persons need to visit the hospital regularly to check their health condition, our system can reduce those visits and reduce the cost of those visits by monitoring their health at home using the healthcare system.

Question 7



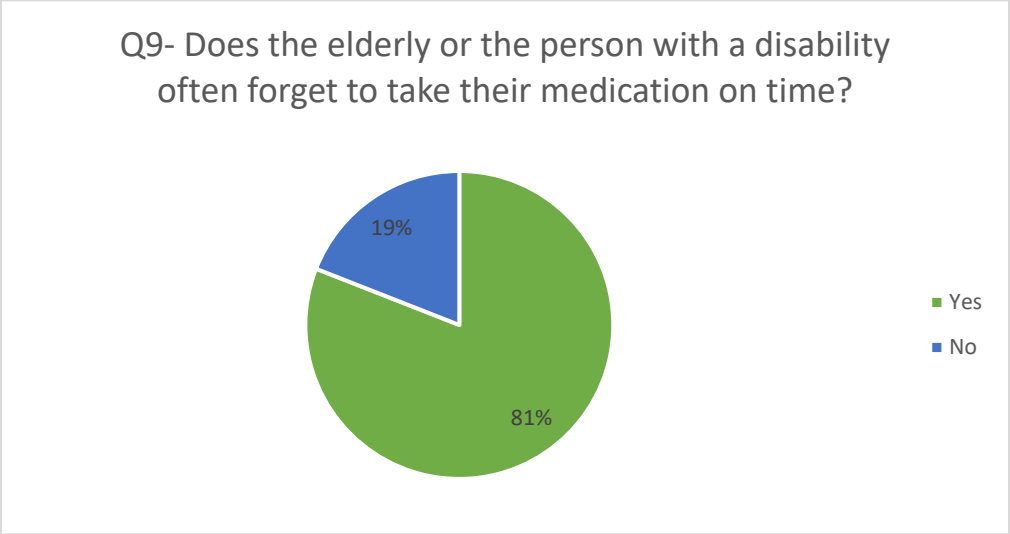
Result of question (7) show that most of the people spend 1000$ - 5000$ yearly only for transportation fees to visit hospitals and doctors, those feeds can be decreased by using our healthcare system because it checks the users health at home.

Question 8



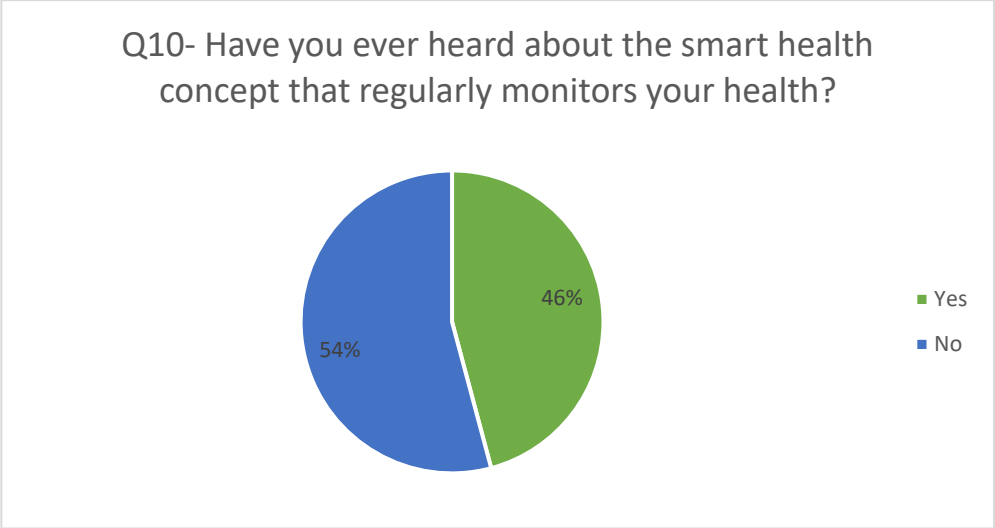
Result of question (8) shows most of the elderly and disabled persons need to take medicines on time.

Question 9



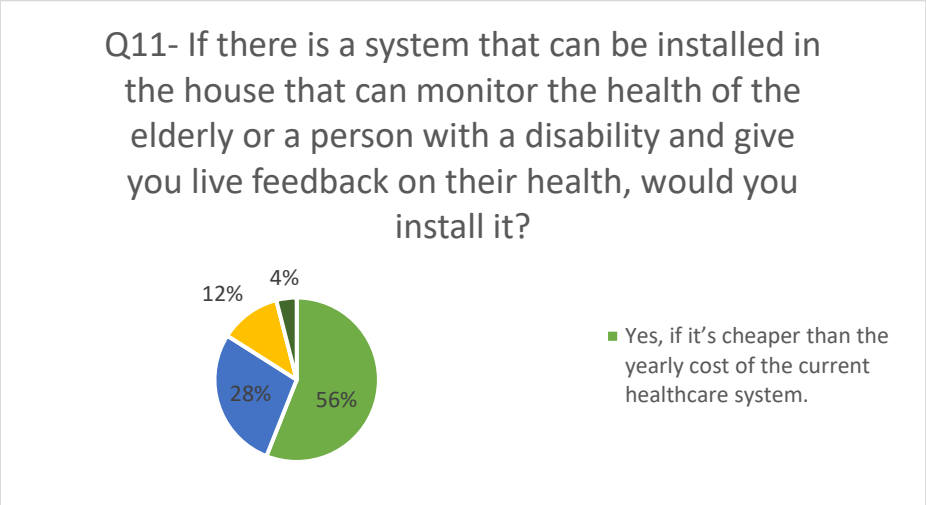
Result of question (9) shows that most of the persons who take medicines on daily basis usually forget to take their medicines on time, those persons can use our system to remind them to take their medicines on time.

Question 10



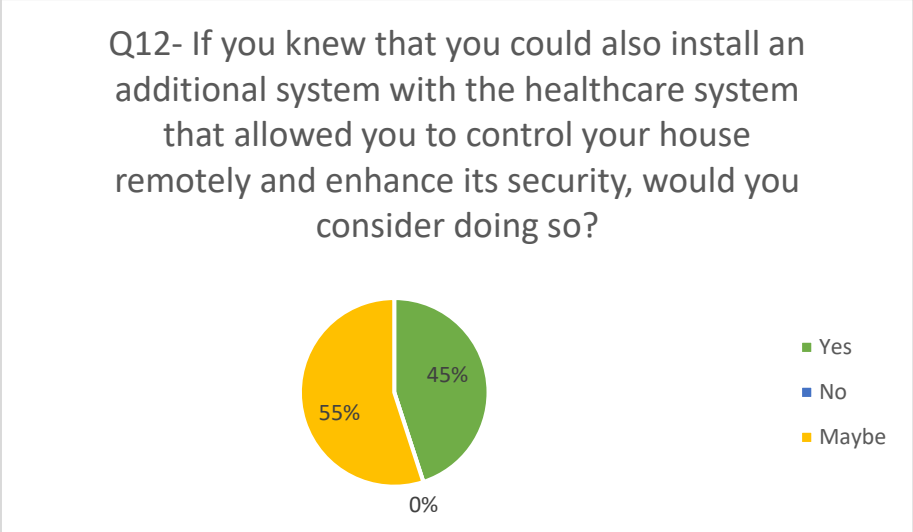
Results of question (10) shows that over 50% of the questionnaire participants did not heard about the smart health system and how much it could help elderly and disabled people.

Question 11



Result of question 11 shows 56% of the participants willing to install the healthcare system to monitor the elderly and disabled people health if it's cheaper than the current system, and 28% are willing to install the system regardless of its cost, 16% prefer not to install the system and still want to use the ordinary methods.

Question 12



Results of question (12) shows most of the people willing to install smart healthcare system.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides an overview of the methodology employed in the project, encompassing its various components. The methodology will be elucidated, with an emphasis on its constituent elements for the purpose of facilitating comprehension. Subsequently, the activities undertaken in each phase will be described, accompanied by Unified Modeling Language (UML) diagrams and other design models. The concluding section of this chapter will delineate the technologies and tools employed in the development of the entire system, encompassing system requirements, device utilization, and a summary of the chapter.

3.2 Methodology Explanation

Agile software development refers to an iterative approach to software development wherein requirements and solutions evolve through collaborative efforts of self-organizing, cross-functional teams. The primary advantage of Agile development lies in its ability to enable teams to deliver value expeditiously, with enhanced quality, predictability, and adaptability to change. Agile serves as an umbrella term encompassing various software development methodologies.

3.3 Scrum Methodology

The Scrum methodology is characterized by its staged approach, known as sprints. Each sprint entails the assignment of specific tasks by the Scrum team master, while the team convenes daily to devise an optimal plan for the working day.

Scrum Advantages::

- Sustained motivation within the team, driven by the desire to meet sprint deadlines.
- Comprehensive understanding of tasks and their timelines through effective sprint planning.
- Adaptability and flexibility in accommodating changing requirements.
- Facilitation of interactive user feedback and subsequent incorporation of feedback through actionable and testable modifications.

Scrum Disadvantages:

- Requirement for skilled individuals.
- Ambiguity regarding the delineation of roles among developers.

3.4 Methodology Choice and Justification

The Scrum methodology has been selected for this project, as it aligns with agile development principles and is rooted in continuous experimentation and feedback loops throughout the software development process. The key rationale behind this methodology selection lies in its inherent flexibility to accommodate changing requirements and its ability to foster close collaboration between the development team and users, thereby leveraging their feedback.

3.5 Phases of Scrum Methodology

a) **Initiate phase:** This phase involves establishing the project vision, identifying stakeholders, Scrum master, Scrum team, developers, and creating a product backlog.
b) **Plan phase:** This phase encompasses task planning and estimation, including the creation of tasks, sprint backlog, and user stories.

c) **Sprint Implementation:** In this phase, the actual implementation of the tasks commences. It involves daily meetings, regular updates and reviews of the backlog, and identification of deliverables.

d) **Reviewing phase:** This phase entails the review of task deliverables, presentation of completed work, identification of gaps and errors, and improvements to the existing work.

e) **Delivering phase:** This final phase encompasses acceptance of the developed work by stakeholders and its preparation for release.

3.6 Design Modeling

Class Diagram

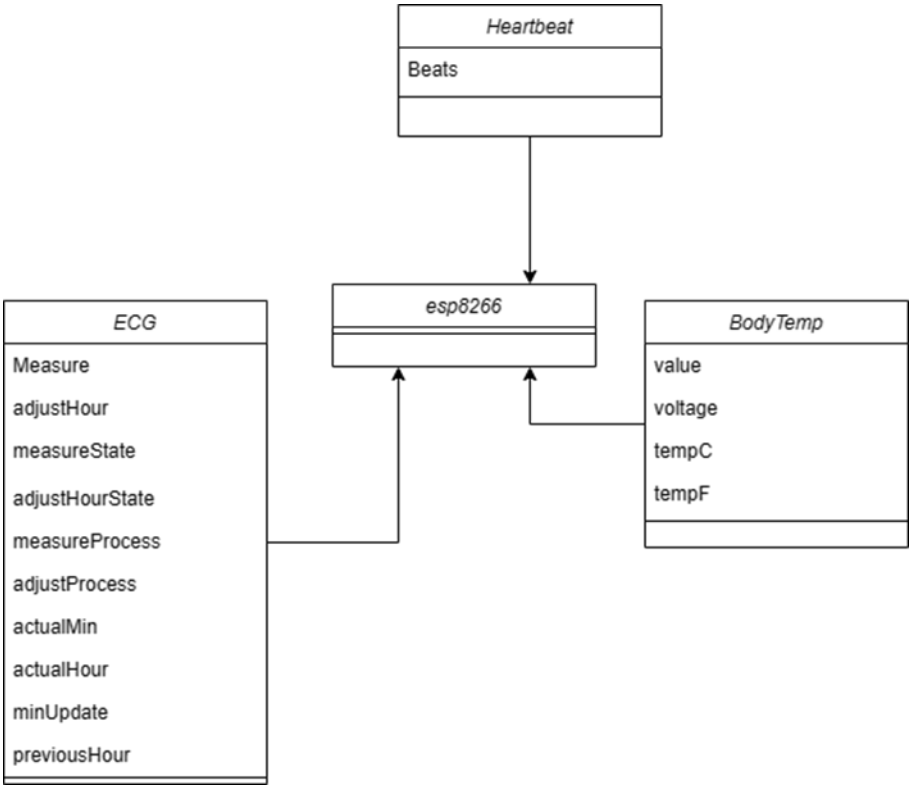


Figure 3-1. Class diagram for the NextPhase healthcare system

3.7 Design Tools

Design tools refer to software programs utilized for prototyping and design purposes. The following tools were employed:

a) **Canva:** An online design and publishing tool that facilitates the easy creation and customization of digital content.

b) **Draw.io:** A free and open-source cross-platform graph drawing software developed in HTML5 and JavaScript. It offers an intuitive interface for creating diverse diagrams such as flowcharts, wireframes, UML diagrams, organizational charts, and network diagrams.

c) **Microsoft Project:** A project management software product developed and offered by Microsoft. It aids project managers in schedule development, resource allocation, progress tracking, budget management, and workload analysis.

3.8 Technology and Tools Used to Develop the System

Software:

a) Visual studio code: A streamlined code editor equipped with features for debugging, task execution, and version control.
b) Firebase: A cloud-hosted NoSQL database that enables real-time data storage and synchronization among users.
c) Arduino IDE: Arduino Integrated Development Environment, or Arduino Software (IDE), provides a platform comprising a code editor, message area, text console, toolbar with essential functions, and menus.

Hardware:

a) Arduino: An open-source hardware and software platform facilitating the design and manufacture of single-board microcontrollers and microcontroller kits for constructing digital devices.
b) Heartbeat sensor: A medical sensor utilized to measure the heart rate in beats per minute.
c) Body temperature sensor: A sensor employed to gauge body temperature.
d) ECG: Electrocardiogram (ECG) measurements encompass an array of wearable sensors, ranging from wet electrode sensors to dry sensors, textile-based sensors, knitted integrated sensors (KIS), and planar fashionable circuit boards.

3.9 Chapter Summary

This chapter has accomplished several objectives, including the selection of a methodology for the project and an in-depth explanation of each component, substantiated by sound justifications. Additionally, the chapter has identified various types of diagrams deemed essential for the project, along with a comprehensive list of design tools employed. By the chapter's conclusion, all utilized software programs have been elucidated, along with pertinent system explanations.

CHAPTER 4

RESEARCH DESIGN AND IMPLEMENTATION

4.1 Introduction

This chapter will conduct a thorough analysis and design of the NextPhase System. This will include the creation of various diagrams, such as a user case diagram, sequence diagram, class diagram, UML diagram, and interface diagram. Additionally, will provide a detailed description of the end users and modules. As part of this process, will discuss the architecture design, database design, and the data dictionary, finally, screen-shots included of the application interface (prototype).

4.2 Requirement Analysis

Functional Requirements

a) Remote monitoring: The system should allow healthcare providers to remotely monitor the health and wellbeing of their patients, including through the use of wearable devices or sensors.

b) Alerts and notifications: The system should be able to send alerts or notifications to healthcare providers in the event of a potential health issue, such as a sudden increase in heart rate or a fall.

c) The system should be able to upload the user health records on a server to be viewed by caregivers.

d) The system should include a panic button to call for help in case of emergencies.

Non-functional Requirements

a) Security: The system should have robust security measures in place to protect patient data and prevent unauthorized access.

b) Privacy: The system should ensure that patient data is kept private and confidential in accordance with relevant laws and regulations.

c) Reliability: The system should be reliable and able to function without interruption, as patients' health and wellbeing depend on it.

d) Scalability: The system should be able to accommodate a growing number of users and handle increased levels of data without degradation in performance.

e) User experience: The system should be easy to use and intuitive for both patients and healthcare providers, with clear and concise user interfaces.

Use Case Diagram

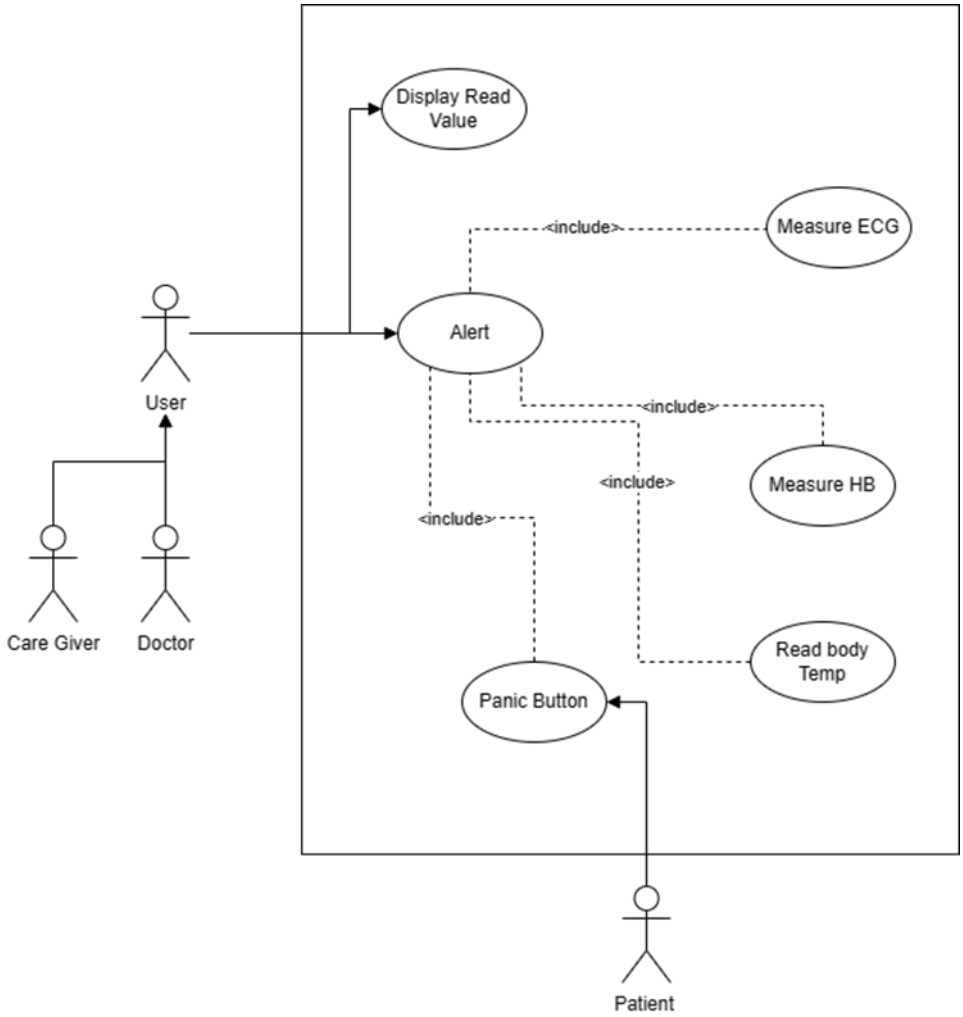


Figure 4-1. Use Case Diagram for the NextPhase healthcare system

Table 4-1: Description of actors

No.	Actors	Description
1	Patient	The person who uses the device that measures the vitals like heart beat rate.

2	Doctor	A person who can access the healthcare data uploaded by the healthcare device that the patient uses, also can receive alert in case of emergency.
3	Caregiver	A person who can access the healthcare data uploaded by the healthcare device that the patient uses, also can receive alert in case of emergency.

Table 4-2: Use Cases Description

No.	**Use Case**	**Description**
1	Panic Button	The patient can use the panic button in case of emergency. For example, the patient want immediate assistant by someone else.
2	Alert	The doctor and caregiver will receive an alert when the system detect abnormal reads from the sensors, for example, the patient heartrate is increased or decreased to a danger level.
3	Display Read Value	The doctor or caregiver can access the data uploaded by the healthcare sensors.
4	Measure HB	Measure Heartbeat per minutes.
5	Read Body Temp	Read body temperature.
6	Measure ECG	Measure ECG values

Sequence Diagram

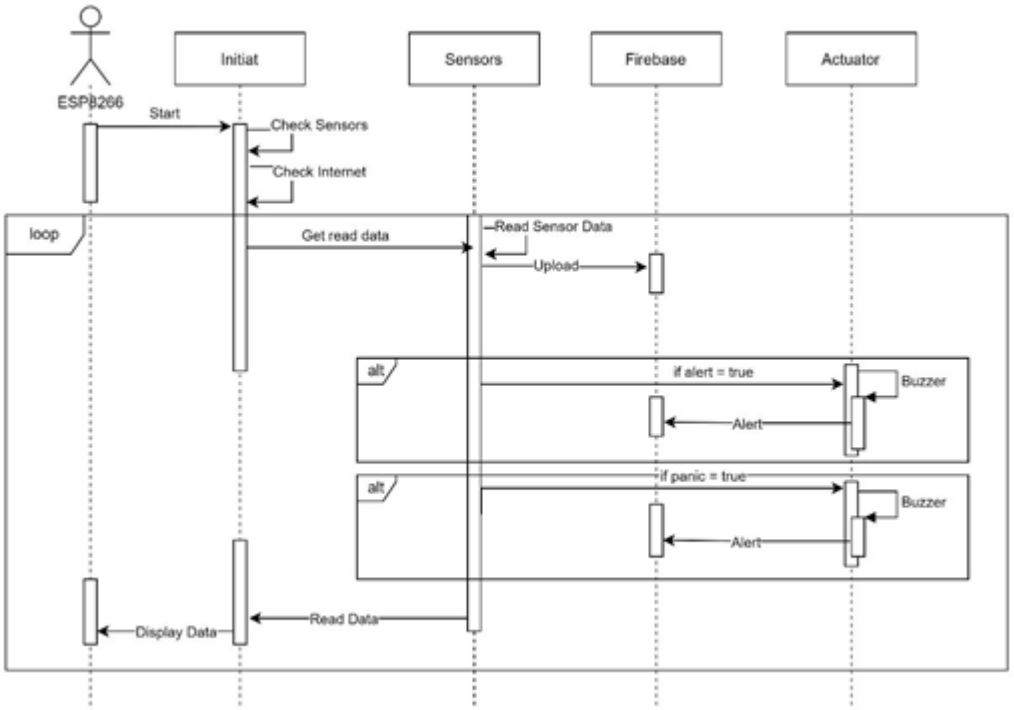


Figure 4-2. Sequence Diagram for the NextPhase healthcare system

Activity Diagram

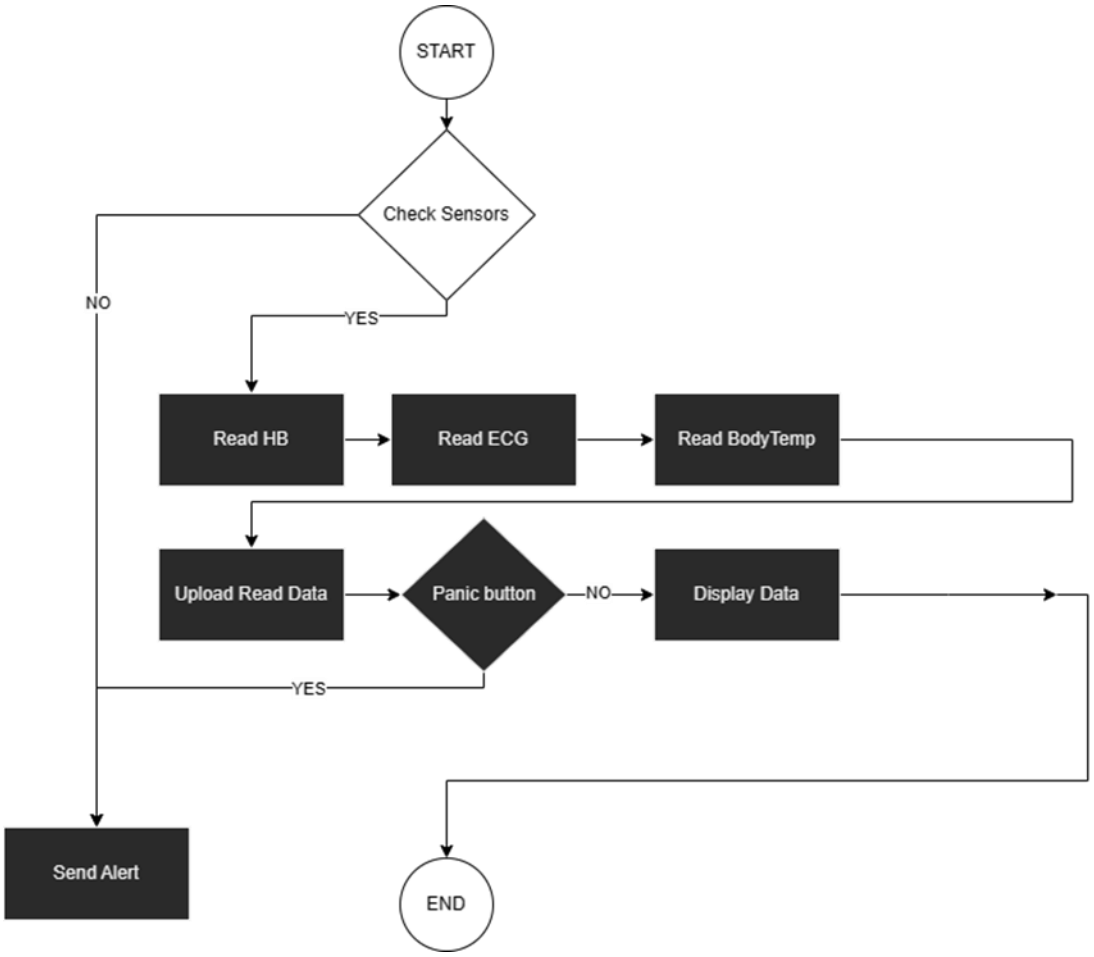


Figure 4-3. Activity Diagram for the NextPhase healthcare system

UML Diagram

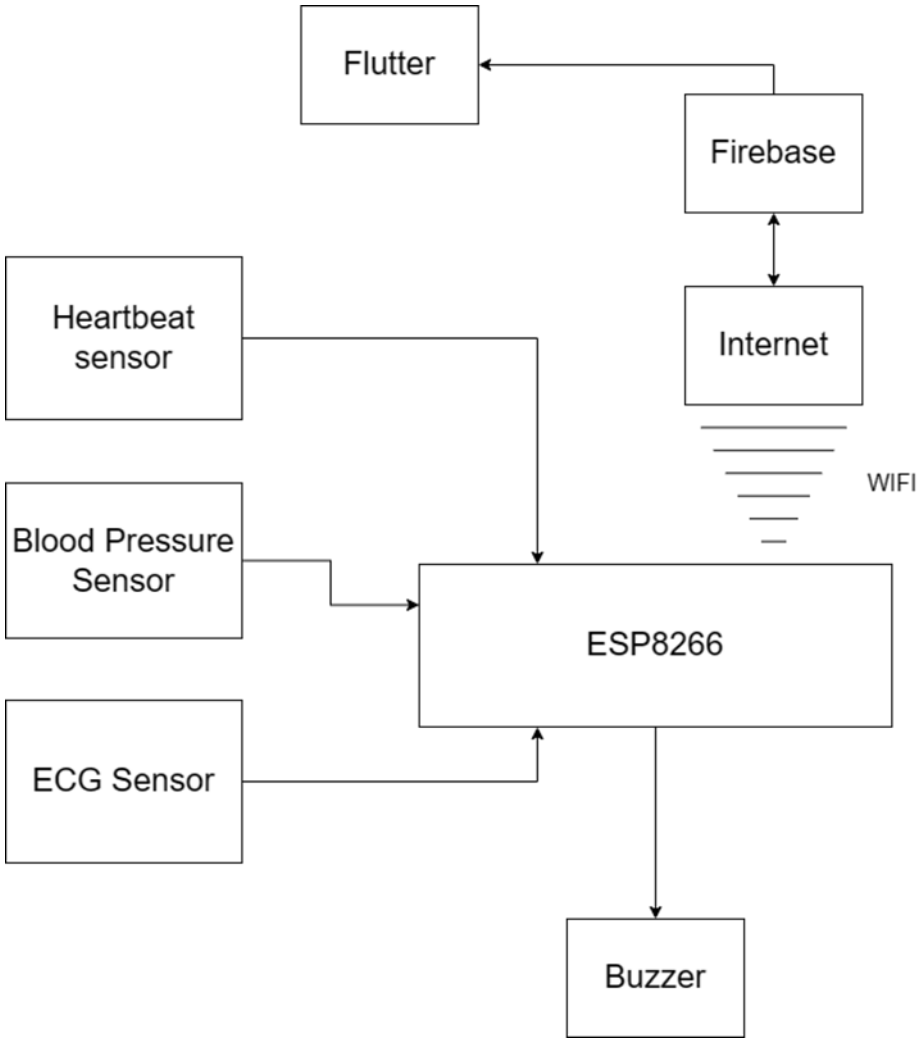


Figure 4-4. UML Diagram for the NextPhase healthcare system

4.3 Architecture Design

An event-driven architecture would involve triggering actions in the system based on events, such as the receipt of data from the sensors. This could involve sending notifications to the doctor and caregiver when certain thresholds are reached or when certain patterns in the data are detected. This type of architecture can be useful for real-time monitoring and can be more scalable than a traditional request-response architecture.

4.4 Database Design

Database design is the process of creating a structured plan for a database. This process involves identifying the data that needs to be stored in the database and designing the structure to hold that data in an organized and efficient manner. Key considerations in database design include selecting appropriate data types, defining relationships between different data entities, and establishing methods for storing and indexing the data. Proper database design is critical to the overall effectiveness, scalability, and reliability of the database.

4.5 Data Dictionary

Table 4-3: bodytemp Dictionary table

Entity	Attribute	Description	Data type	Null
BodyTemp	value	variable to hold current beat value	number	no
	Temp c	Temperature in Celsius degrees	number	no
	Temp f	Temperature in Fahrenheit degrees	number	no

Table 4-4: ECG Dictionary table

Entity	Attribute	Description	Data type	Null
Measure	value	variable to hold current beat value	number	no
adjustHour	sec	Adjust the hour	number	no

measureState	0 -1	Measure the current state	number	No
adjustHourState	hr	Adjust the hour in current state	number	no
measureProcess	num	Measure the process	number	no
adjustProcess	num	Adjust the process	number	no
actualMin	sec	Current minute	number	no
actualHour	sec	Current hour	number	no
minUpdate	sec	Update the current minute	number	no
PreviousHour	sec	Hold the previous hour	number	no

Table 4-5: heartbeat Dictionary table

Entity	**Attribute**	**Description**	**Data type**	**Null**
heartbeat	beats	Heartbeat ratio per minute	number	yes

4.6 Interface Design

Interface design refers to the design of the user interface (UI) of an application, which is the way that the user interacts with the application. It includes the layout of the various elements on the screen, the appearance of the elements, and the overall look and feel of the application. Effective interface design is important because it can significantly impact the user's experience with the application. A well-designed interface will be easy to use, intuitive, and aesthetically pleasing, which can improve the user's overall satisfaction with the application. On the other hand, a poorly designed interface can be confusing, frustrating, and hard to use, which can result in a negative user experience.

Figures 4-5, 4-6, and 4-7 below shows the examples of user interface for health monitoring application system.

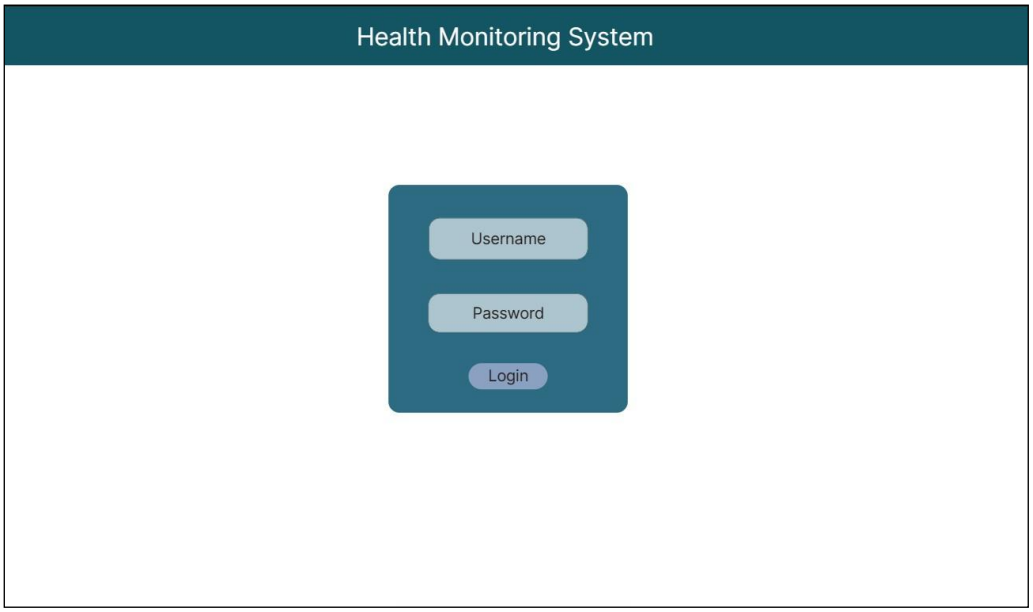


Figure 4-5. Login interface for the NextPhase healthcare system

The login interface is simple, the doctor or the caregiver will be registered in the system database, and have a user name and password to enter the system. After login in successfully the system will show the active patient (elderly or disabled person) name (as showed in Figure 4-5 below)

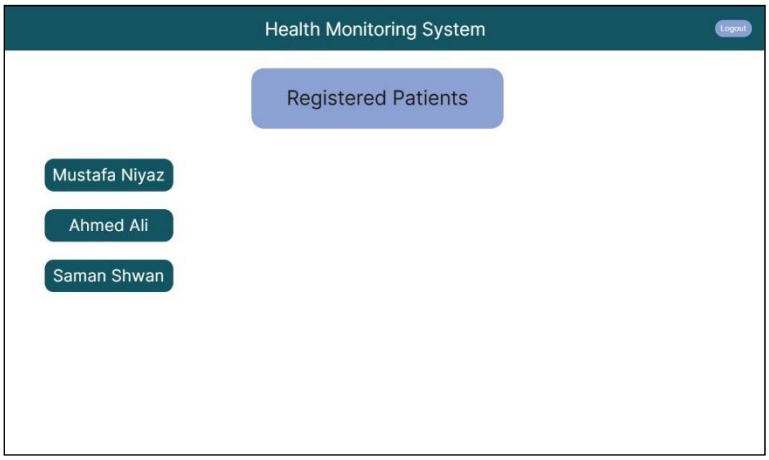


Figure 4-6. Registered patients page view

After choosing the patient name, a new page will appear (as showing in Figure 4-6 below) showing the health sensors readings for that patient

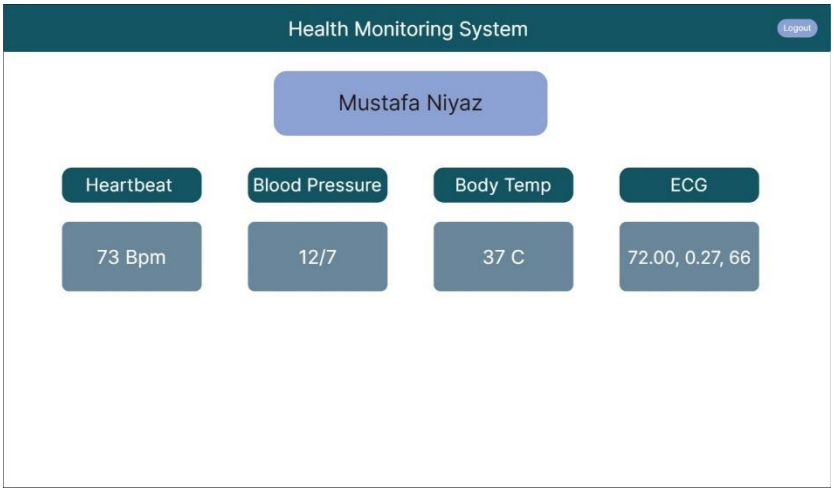


Figure 4-7. Sensors reading for a patient page view

4.7 Chapter Summary

This chapter covers requirement analysis and design in detail. Described were the functional and non-functional aspects. In addition, multiple diagrams were created, including a use case diagram, a sequence diagram, and an activity diagram. This chapter concludes with a discussion of the system's architecture and interface design, as well as screen shots of the system's interface.

CAHPTER 5

RESULTS, ANALYSIS AND DISCUSSION

5.1 Introduction

The implementation and testing phase holds paramount importance in the development of the smart healthcare system. This chapter presents a comprehensive overview of the implementation process and highlights the critical role of testing in ensuring system functionality and user satisfaction. By examining the findings and outcomes of both white box testing and user testing, valuable insights into the system's performance and usability are provided.

5.2 Coding Of the System Main Functions

```
void loop() {
  ecg = 0;
  if ((digitalRead(LOPlus_PIN) == 1) || (digitalRead(LOMinus_PIN) == 1)) {
    Serial.println("!");
  } else {
    ecg = analogRead(ECG_PIN);
  }
  Serial.println(ecg);
  //Firebase.setInt(firebaseData, "/ecgReadings/value", ecg);

  if (lastECG < threshold && ecg >= threshold) {
    unsigned long beatTime = millis() - lastBeat;
    bpm = 60000 / beatTime;
    lastBeat = millis();
  }
  lastECG = ecg;

  bool panicButton = digitalRead(BUTTON_PIN);
  if (!panicButton) {
    Serial.println("Clicked.");
  }

  static unsigned long timer = millis();
  if (millis() - timer > TimeCalculation) {
    timer = millis();
    float temperature = readTemperature();
    Serial.println("BPM: " + String(bpm));
    Serial.println("Temp: " + String(temperature));
    Serial.println("ECG: " + String(ecg));
    Serial.println("==============================");
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("BPM: ");
    lcd.print(bpm);
    lcd.setCursor(0, 1);
    lcd.print("Temp: ");
    lcd.print(temperature);
    lcd.setCursor(0, 3);
    lcd.print("ECG: ");
    lcd.print(ecg);
```

Figure 5-1. ESP Main Function Code Sample

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

import 'firebase/firebase_methods.dart';

class LoginScreen extends StatefulWidget {
  const LoginScreen({super.key});

  @override
  State<LoginScreen> createState() => _LoginScreenState();
}

class _LoginScreenState extends State<LoginScreen> {
  final GlobalKey<FormState> _formKey = GlobalKey<FormState>();
  final TextEditingController emailController = TextEditingController();
  final TextEditingController passwordController = TextEditingController();
  @override
  Widget build(BuildContext context) {
    return Scaffold(
      backgroundColor: Colors.white,
      body: Padding(
        padding: const EdgeInsets.all(16.0),
        child: Column(
          mainAxisAlignment: MainAxisAlignment.center,
          crossAxisAlignment: CrossAxisAlignment.stretch,
          children: <Widget>[
            const Icon(
              Icons.local_hospital,
              color: Colors.green,
              size: 100,
            ),
            const SizedBox(height: 48.0),
            const Text(
              "Health Monitoring System",
              textAlign: TextAlign.center,
              style: TextStyle(
                fontSize: 24.0,
                color: Colors.green,
                fontWeight: FontWeight.bold,
              ),
            ),
            const SizedBox(height: 48.0),
            Form(
              key: _formKey,
              child: Column(
                children: <Widget>[
                  TextFormField(
```

Figure 5-2. Application Log Screen Code Sample

```dart
import 'package:auto_route/auto_route.dart';
import 'package:firebase_database/firebase_database.dart';
import 'package:flutter/material.dart';
import 'package:health_monitor/routes/routes.gr.dart';
import 'package:provider/provider.dart';

import 'firebase/firebase_methods.dart';

class PatientCaregiverScreen extends StatefulWidget {
  const PatientCaregiverScreen({super.key});

  @override
  // ignore: library_private_types_in_public_api
  _PatientCaregiverScreenState createState() => _PatientCaregiverScreenState();
}

class _PatientCaregiverScreenState extends State<PatientCaregiverScreen> {
  final dbRef = FirebaseDatabase.instance.ref();
  ValueNotifier<Color> bpmCardColor = ValueNotifier<Color>(Colors.white);
  ValueNotifier<Color> tempCardColor = ValueNotifier<Color>(Colors.white);
  ValueNotifier<Color> panicCardColor = ValueNotifier<Color>(Colors.white);
  @override
  Widget build(BuildContext context) {
    return Scaffold(
      appBar: AppBar(
        automaticallyImplyLeading: false,
        title: const Text('Patient Details'),
        backgroundColor: Colors.green,
        actions: [
          IconButton(
            onPressed: () {
              context
                  .read<FirebaseAuthMethods>()
                  .signOut(context)
                  .then((value) => context.router.push(const LoginRoute()));
            },
            icon: const Icon(Icons.logout),
          ),
        ],
      ),
```

Figure 5-3. Caregiver View Screen Code Sample

5.3 Interfaces of System Main Functions

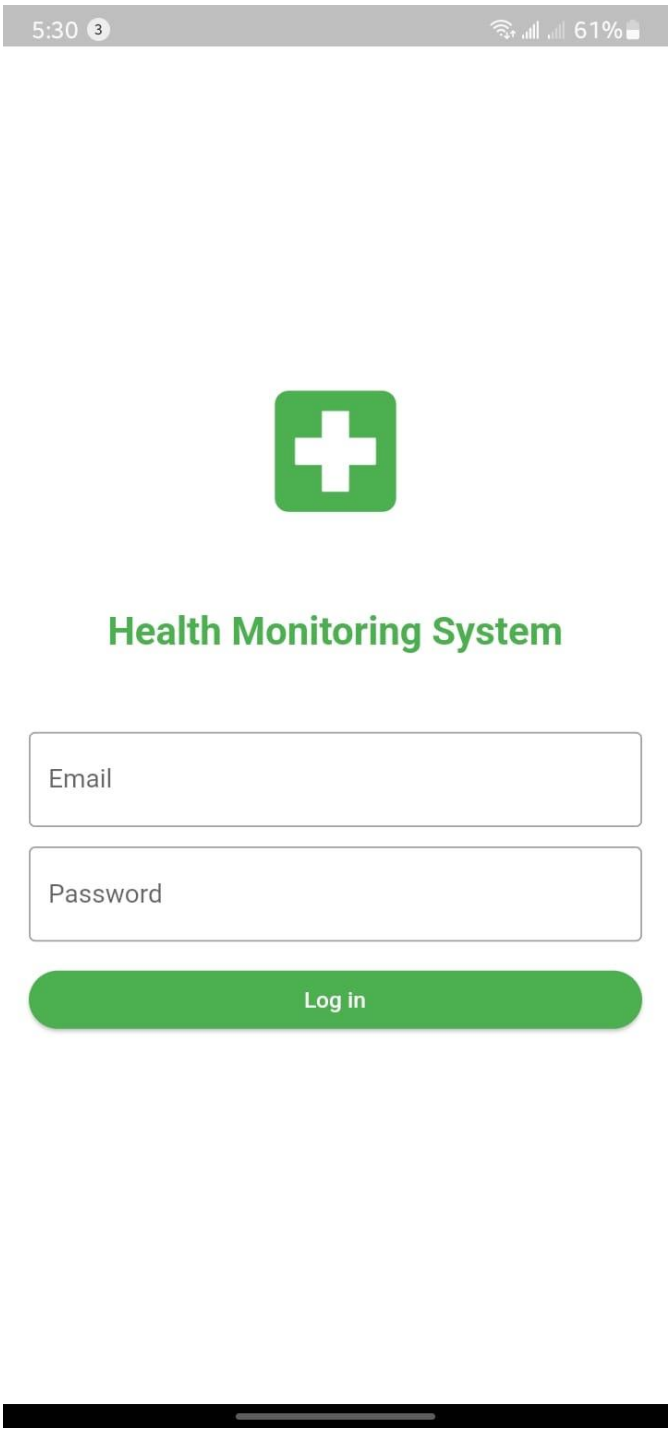


Figure 5-4. Login Screen

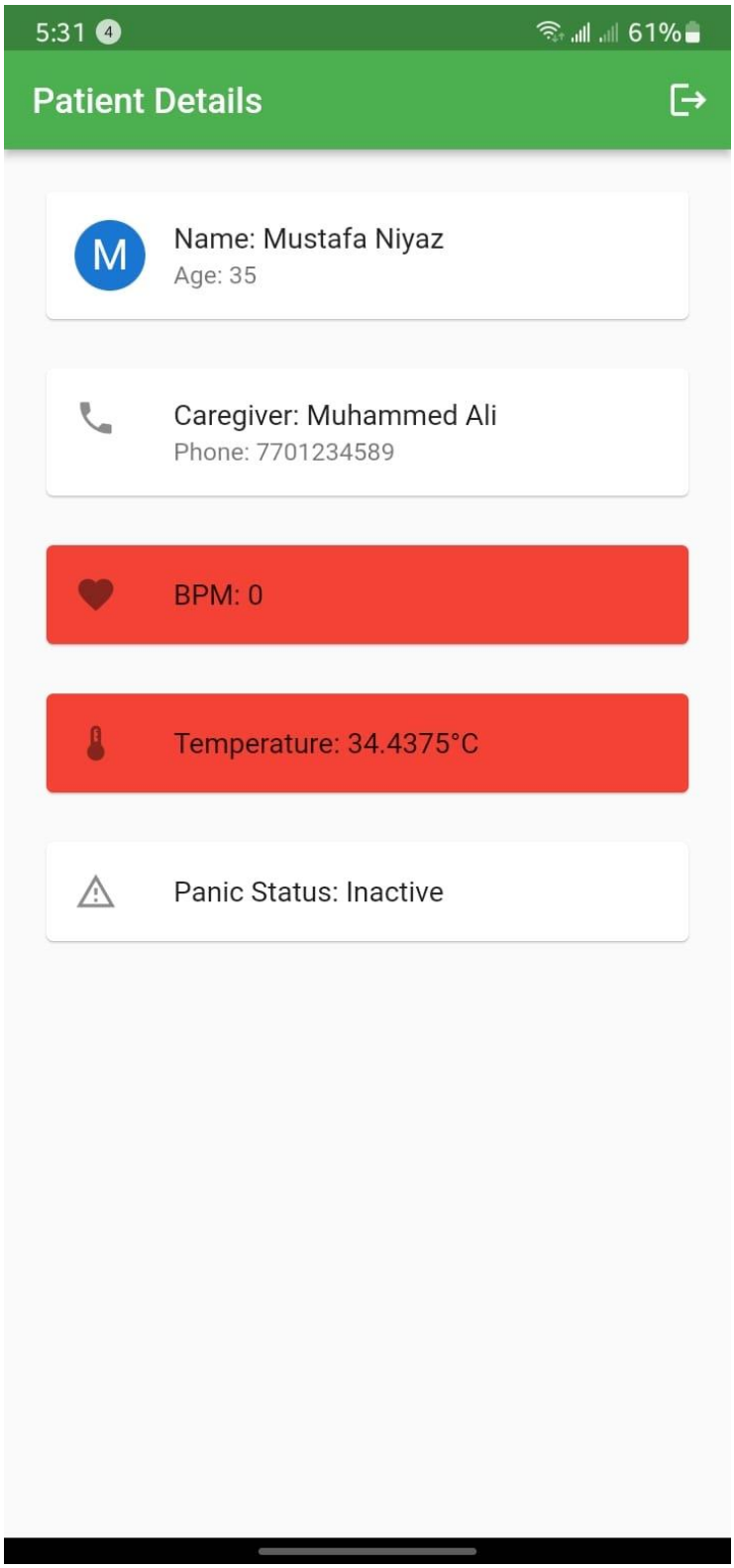


Figure 5-5. Caregiver Main Screen

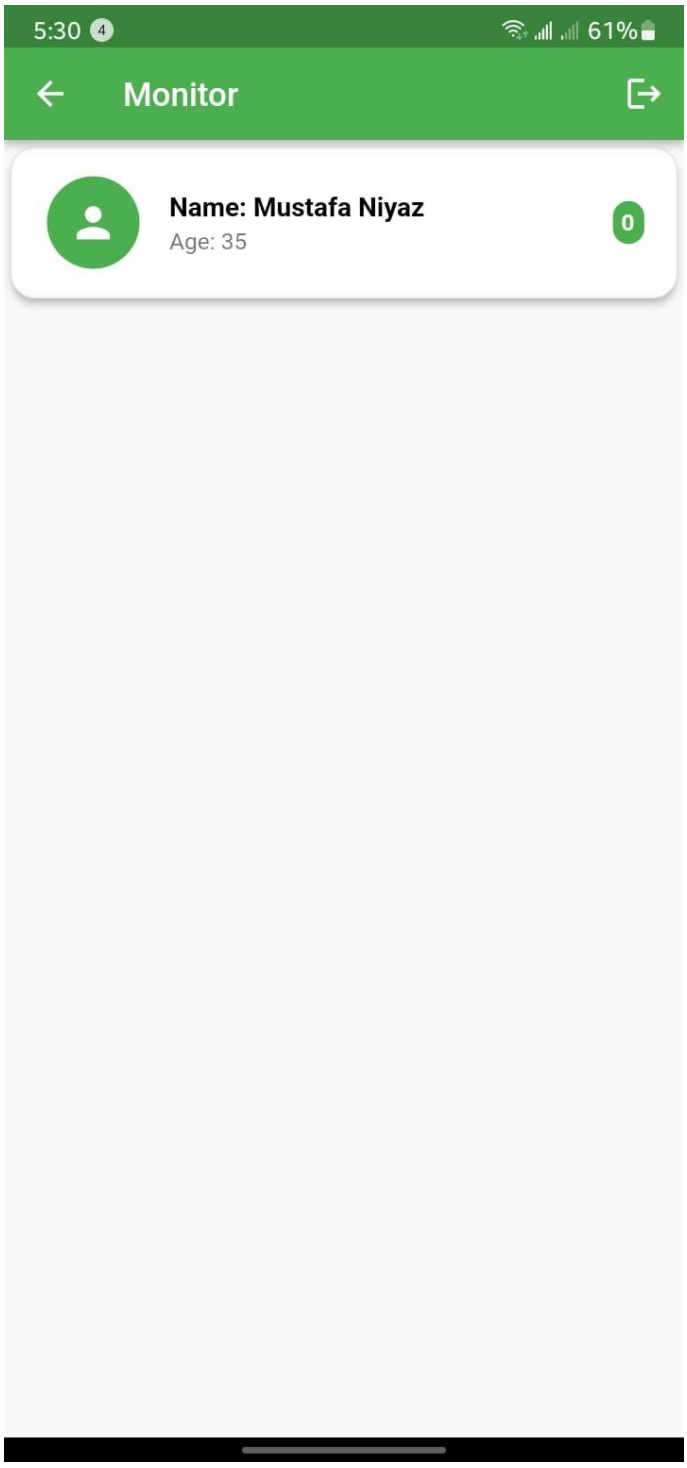


Figure 5-6. Doctor Patient List Screen

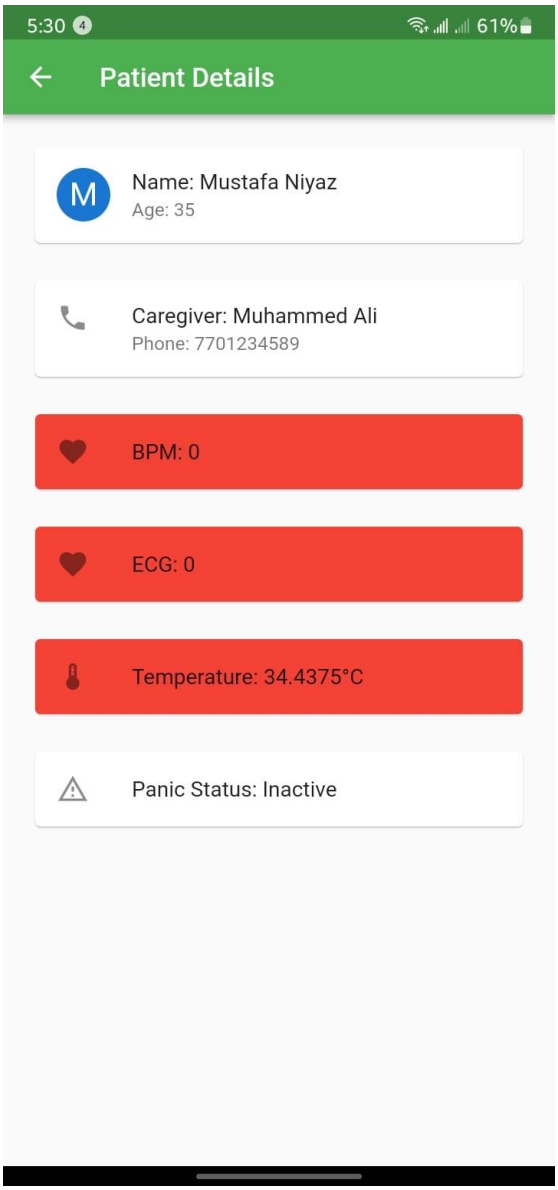


Figure 5-7. Doctor Main Screen

5.4 Testing

This section comprehensively explores the implementation and testing of the smart healthcare system. The importance of the implementation process and the meticulous testing procedures are effectively conveyed. The black box, white box, and user testing sections provide detailed explanations of the methodologies employed, the results obtained, and the subsequent analysis conducted.

5.4.1 Black Box Testing

Black box testing is a software testing technique where the internal workings, structure, and implementation details of the system under test are not known to the tester. Instead, the tester focuses solely on the inputs provided to the system and the corresponding outputs it produces. In other words, the tester treats the system as a "black box," where they are only concerned with understanding the system's functionalities and expected behaviors, without knowledge of the internal code or architecture. Below table shows the results of testing some functionalities of the system:

Table 5-1: Black Box Test Table

Test	Test Type	Test Data	Reason	Expected outcome	Actual Outcome	Pass/Fail
#01	Valid	doctor@gmail.com	Login functionality	Doctor account login successfully	Doctor account login successfully	Pass
#02	valid	mustafa@gmail.com	Login functionality	Caregiver account login successfully	Caregiver account login successfully	Pass
#03	invalid	abcd@gmail.com	Login functionality	Login failed, no such account	Login failed, no such account	pass
#04	Null value	Sensor reading	Sensor data display	The displayed data on the screen are the same as the application	The data reading for all the sensors are the same	pass
#05	Null Value	Press the button	Panic button alert	The application notify the user	Delay or fail to notify	Fail
#06	Valid	doctor@gmail.com	Account permission	The doctor can see the ECG reading along with the other sensors	Doctor account can see all the sensors readings	Pass
#07	Valid	mustafa@gmail.com	Account permission	The caregiver account only sees the heartbeat and body temperature sensor readings	Caregiver account can see only heartbeat and body temperature sensors	pass

5.4.2 System Flow

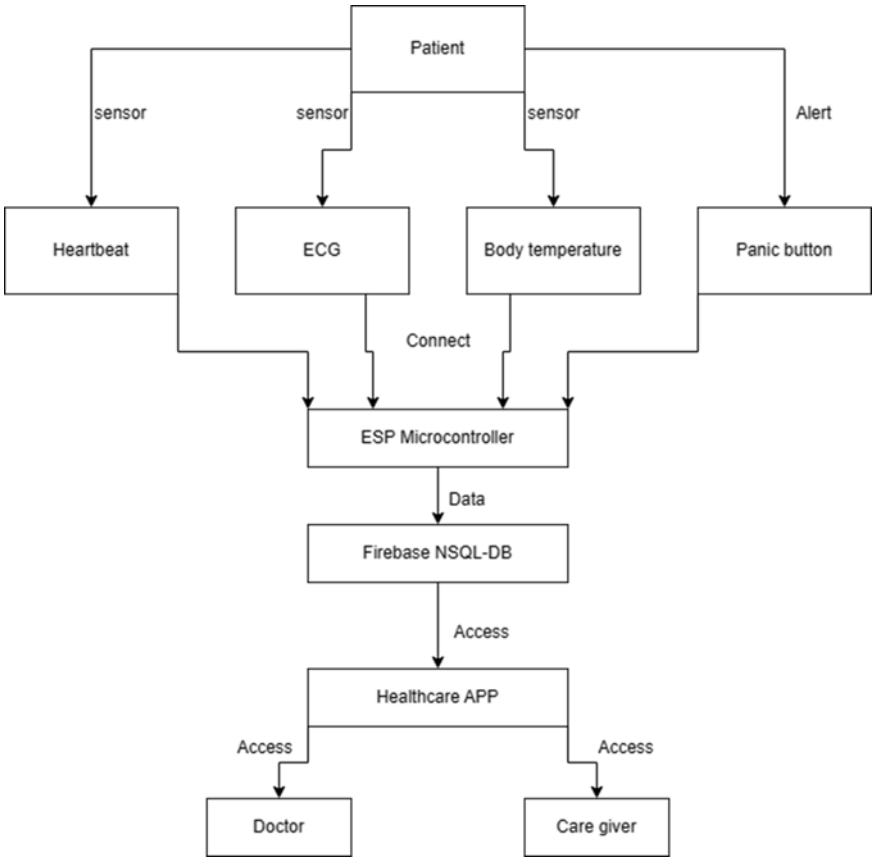


Figure 5-8. Caregiver View Screen Code Sample

5.4.3 Input Output Verification

Input and output verification testing for this system involves validating the correctness and accuracy of the system's inputs and outputs. It ensures that the system processes the inputs correctly and produces the expected outputs. Here's an example of input and output verification testing for the described system:

5.4.4 Input Verification Testing

Table 5-2: Input Verification Testing table

Test	Objective	Expected result	Test result
#01	To verify the input reading from sensors are stored correctly in the firebase database	Inputs are received and stored correctly	Pass
#02	To verify that the system handles invalid or unexpected sensor data input gracefully.	The system should read zero values in case of invalid data	pass

5.4.5 Output Verification Testing

Table 5-3: output Verification Testing table

Test	Objective	Expected result	Test result
#01	To verify that the system displays real-time sensor data accurately on the application.	The data displayed on the application should be the same as the screen	Pass
#02	To verify the generation and delivery of notifications to the doctor and caregiver.	The system should send notification to the user when the panic button is pressed	Fail

5.4.6 Error Messages

Error message testing for this system involves validating the correctness, clarity, and usability of the error messages generated by the system. The purpose is to ensure that when errors or exceptional situations occur, the system provides informative and user-friendly messages that help users understand the issue and take appropriate action. Below table shows error testing done on the system:

Table 5-4: Error Message Testing table

Test	Test Data	Reason	Displayed Message	Pass/Fail
#01	abcd@gmail.com	Verify that the system provides clear and informative error messages when invalid login credentials are entered.	There is no user records corresponding to this identifier	pass
#02	Minus number	Ensure that the system generates meaningful error messages when there is missing or incomplete sensor data.	N/A	Fail
#03	N/A	Ensure that the system communicates network-related errors effectively to the user when the network has errors.	N/A	Fail

5.4.7 White Box Testing

White box testing involves a meticulous examination of the internal structure and logic of the system. Various testing techniques, including unit testing and integration testing, were employed to meticulously assess individual components and their interactions. The primary objective of the white box testing phase was to ensure the accuracy and efficiency of the system's algorithms, data processing capabilities, and networking functionalities. The results and findings derived from the white box testing phase are presented, accompanied by a comprehensive analysis of any issues or challenges encountered throughout the testing process. This analysis sheds light on

the internal functionality of the system and identifies areas that require further improvement. Below table show the results of white box testing for the system:

Table 5-5: White Box Testing table

Test	approach	Component	Test Reason	Expected Result	Actual Result	Pass/Fail
#01	Unit Test	ECG Sensor	Check if the sensor read data from patient	ECG sensor is reading data correctly	ECG Sensor is working properly	pass
#02	Unit Test	Body temperature sensor	Check if the sensor read data from patient	Body temperature sensor is reading data correctly	Body temperature Sensor is working properly	pass
#03	Unit Test	Heartbeat sensor	Check if the sensor read data from patient	Heartbeat sensor is reading data correctly	Heartbeat Sensor is working properly	pass
#04	Integration Testing	ESP sending data to the database server	Check if ESP is receiving data from sensors and sent it to database system	Database is receiving data from ESP	Database server can receive data from the ESP	pass
#05	Integration Testing	Mobile application receiving data from database	Check if the mobile application is receiving sensors data from firebase database	Mobile application is receiving data from database	Mobile application can read data from the database	pass
#06	System Testing	Panic button send notification	Check if panic button send notifications to the users	Mobile application should notify users when panic button is pressed	Delay or fail to send notification	fail

5.5 User Testing

User testing is an essential evaluation process that focuses on assessing the system's usability, user experience, and overall satisfaction. A well-defined user testing methodology was devised, encompassing the selection of representative users and the creation of realistic test scenarios. Participants were carefully guided through various tasks, and their interactions with the system were observed and recorded. To gather valuable user feedback and observations, a combination of surveys, interviews, and direct observation during testing sessions was employed. The results obtained from the user testing phase are presented, encompassing user satisfaction levels, identified usability issues, and recommendations for improvement.

5.5.1 Test Case (Doctor's User Test)

Evaluate the system's ability to provide real-time sensor data and emergency notifications to the doctor.

Tester name: Arivan shamal		
Objective: Evaluate the system's ability to provide real-time sensor data and emergency notifications to the doctor.		
Instructions	Expected Results	Test Result
Navigate to the ECG, heartbeat, and temperature screens.	Verify that the displayed data reflects the current sensor readings and updates in real-time.	Pass

5.5.2 Test Case (Caregiver’s User Test)

Tester name: Zhin Abdalqadir		
Objective: Evaluate the system's usability for the caregiver in terms of login process and monitoring the patient's sensor data.		
Instructions	Expected Results	Test Result

Enter caregiver's credentials and log in to the mobile application.	Successfully log in without any issues and verify that the caregiver-specific functionalities are accessible.	Pass

5.6 Chapter Summary

The implementation and testing phase plays a pivotal role in the development of the smart healthcare system, ensuring its effectiveness and adherence to user needs. The white box testing phase delves into the system's internal workings, assessing its accuracy and efficiency. By examining the internal structure and logic, this phase provides vital insights into the system's overall functionality. User testing, on the other hand, evaluates the system from an end-user perspective, considering aspects such as usability and user satisfaction. The findings derived from both testing phases significantly contribute to understanding the system's performance, strengths, limitations, and areas that necessitate improvement. Based on the outcomes of the testing process, comprehensive recommendations for further enhancements and refinements are provided. Ultimately, the implementation and testing phase reinforces the substantial significance of the smart healthcare system in promoting the quality of life for elderly and disabled individuals.

CHAPTER 6

RECOMMENDATION & CONCLUSION

6.1 Introduction

This chapter will discuss the process and the stages of implementing this project and o suggestions to improve this system in the future.

6.2 Achievement of Project Objectives

Our literature review and analysis allowed us to understand the needs of our proposed system, which enabled us to determine the necessary functionalities and user flow. This helped us to consider how the system would generate and store data, as well as how it would connect to other systems. The analysis also gave us a good understanding of how the system should be implemented. One of our goals in developing this system was to improve the healthcare system for elderly and disabled individuals by analyzing existing research and applications and gathering feedback from users. This allowed us to identify problems with the current system and determine how to address them. Another goal was to design and develop an application that would allow caregivers to view sensor readings. This required understanding how the system should work and interact with users, as well as designing the interface.

6.3 Suggestions for Future Improvement

The number of sensors can be increased to cover more healthcare aspects; for instance, sleeping patterns of the elderly can be monitored. Additionally, the system can be integrated with a smart house system; by adding falling and movement detection

sensors, as well as machine learning algorithms, the patient's movement patterns can be learned, and detect any abnormalities. To make the smart healthcare system appealing to a large number of users, researchers and developers must continually consider the privacy of the users and the cost of implementation.

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APPENDIXES A PROJECT GANTT CHARTS

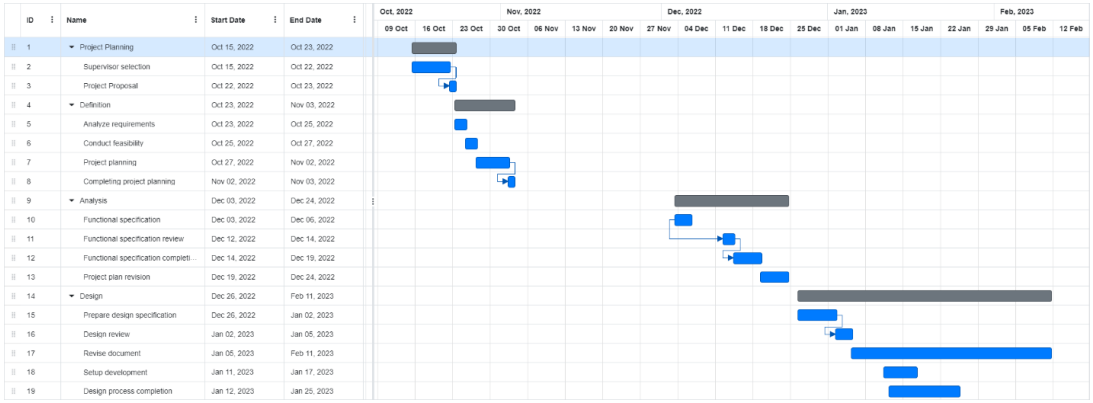

Figure 1-1. Project Gantt chart

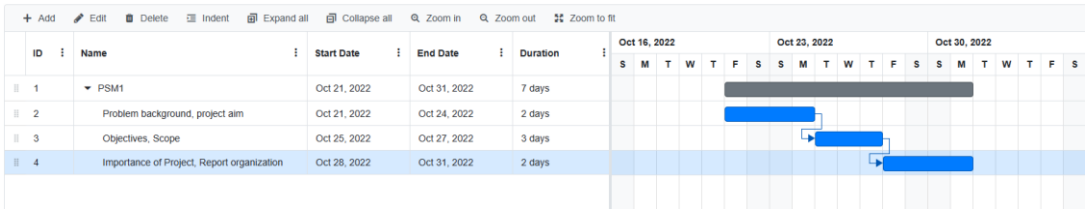

Figure 3-4. PSM 1 Gantt chart

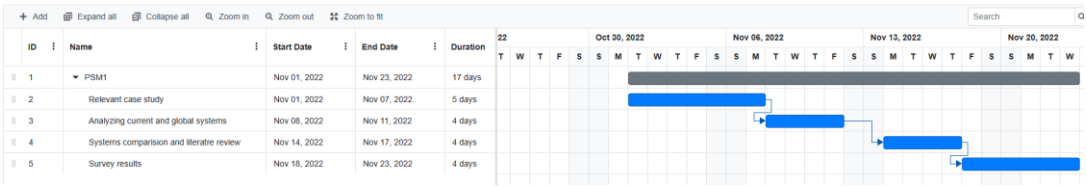

Figure 3-5. PSM 2 Gantt chart

APPENDIXES B QUESTIONS OF THE SURVEY

Q1- Do you (or know someone) who is taking care of an elderly person or a person with any kind of disability? *

- ○ Yes
- ○ No (Stop the survey)

Q2- What is the age of the elderly or the person with a disability? *

- ○ 18 - 30
- ○ 31 - 50
- ○ Over 50

Q3- Does the elderly or the person with a disability live alone? *

- ○ Yes
- ○ No

Q4- Does the elderly or the disabled person need someone to take care of him/her regularly? *

- ○ Yes
- ○ No

Q5- Does the elderly or the disabled person need someone to stay with him/her all the time? *

- Yes
- No

Q6- Does the elderly or the disabled person need to visit the hospital or a doctor regularly? *

- Yes
- No

Q7- What is the estimated yearly cost of regular visits to the hospital or the doctor (including the transportation cost)? *

- Below 1000$
- Between 1000$ - 5000$
- Over 5000$

Q8- Does the elderly or the disabled person need to take daily medication on time? *

- Yes
- No

Q9- Does the elderly or the person with a disability often forget to take their medication on time? *

- Yes
- No

Q10- Have you ever heard about the smart house concept that regularly monitors your health? *

- Yes
- No

Q11- If there is a system that can be installed in the house that can monitor the health of the elderly or a person with a disability and give you live feedback on their health, would you install it? *

- Yes, if it's cheaper than the yearly cost of the current healthcare system.
- Yes, I will install it regardless of its cost.
- No, I prefer to take the elderly or a person with a disability to the doctor myself.
- No, I have hired a person to do that regularly.

Q12- If you knew that you could also install an additional system with the healthcare system that allowed you to control your house remotely and enhance its security, would you consider doing so? *

- Yes
- No
- Maybe, if its affordable