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# Mobile application to assist cancer patients access healthcare and funding in Kenya

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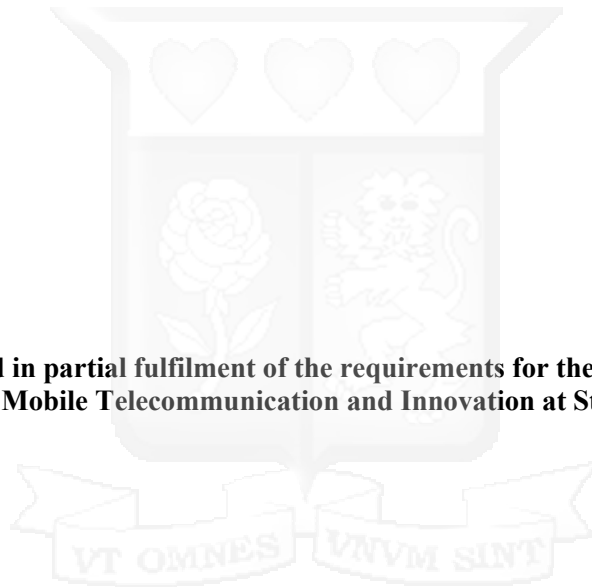
# Mobile Application to Assist Cancer Patients Access Healthcare and Funding in Kenya

## Serem Mercy Chepchirchir

**Submitted in partial fulfilment of the requirements for the Degree of
Master of Science in Mobile Telecommunication and Innovation at Strathmore University**

**Faculty of Information Technology**

**Strathmore University**

**Nairobi, Kenya**

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# Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

Serem Mercy Chepchirchir,

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**Approval**

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# Abstract

Cancer has posed to be a killer disease over time. Most patients die of cancer due to lack of access to early screening and effective treatment and lack of medical funds. Cancer treatment is deemed expensive thus most patients would need a health insurance fund or donor to offset the hospital bill. Cancer patients also need information on where they can access quality health service.

There are several stakeholders who have joined forces to overcome the cancer burden. The government of Kenya has spearheaded the initiative by introduction of NHIF cover, covering cancer treatment. Cancer patients can be treated at NHIF approved hospitals using the capped cover amount. There are also Non-governmental organisations and cancer fund drives that have been organised to assist in the cancer burden in Kenya.

Data was collected using questionnaires, the data collected was used to find out the challenges faced when accessing health care and funding. Data was analysed using Google analytics tools and results obtained were used to guide the researcher in the design of the mobile and web application. Agile software methodology was used to develop the application.
A mobile and web application was developed to assist cancer patients to access health care and funding. Users of the system are required to register their details that consist of their bio data as well as their NHIF number. The details of the user are sent to the donor to assist in paying the monthly contribution as well as the deficit amount to cover the full cancer treatment. Users are also referred to an oncologist and Hospital facility upon appointment request.
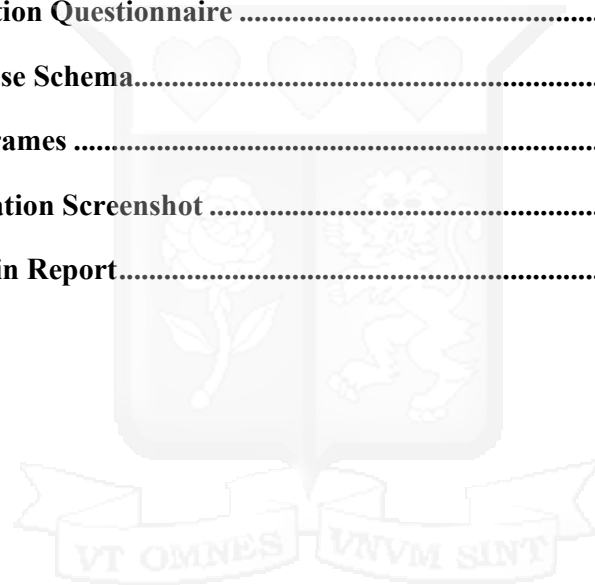
**Keywords: Cancer, NHIF, stakeholders, healthcare and funds.**

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# List of Acronyms

AMPATH       Academic Model Providing Access to Healthcare

KNH           Kenyatta National Hospital

MTRH        Moi Teaching and Referral Hospital

NHIF         National Health Insurance Fund

NHS           National Health Service

PHI            Private Health Insurance

# Dedication

I dedicate this project firstly, to my heavenly Father for giving me the strength and wisdom. Secondly, I dedicate it to @iLabAfrica and Safaricom Academy for the opportunity and support to complete my master's degree and thirdly, I dedicate this project to my project supervisor Dr. Vitalis Gavole Ozianyi for believing in me. Lastly, I dedicate this project to my family and friends.

# Acknowledgements

Firstly, I would like to Acknowledge God for his grace, strength and help throughout this project. I would also like to appreciate my supervisor Dr. Vitalis Gavole Ozianyi for his advice and guidance towards the completion of my dissertation. I also appreciate Safaricom Academy and @iLabAfrica for granting me the scholarship. Finally, I give my gratitude to my family, friends and colleagues who assisted me throughout my dissertation.

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background of the Study

According to the World Health Organisation (2015), cancer is a general term for a large group of diseases that is characterized by the growth and the spread of irregular cells beyond their normal limits that can then enter attached parts of the body or blowout to other organs. Cancer arises from the transformation of normal cells into tumour cells in a multistage process that generally progresses from a pre-cancerous lesion to a malignant tumour.

Cancer is the second leading cause of death worldwide behind cardiovascular disease (Nagai & Kim, 2017). According to the Global Burden of Disease (2015) Study, which was done as a comprehensive regional and worldwide research program evaluating the mortality and impairment that has been caused by major illnesses and risk factors they found out that cancer mortality decreased between 2005 and 2015, notwithstanding the global incidence rates of cancer increasing during this period. However, there are developments in cancer survival rates due the use of precision medicine or immunotherapy that have mostly happened in countries with high income, whereas countries with low income, cancer prevention, education, and access to cancer screening tests as well as cancer treatment are inadequate (Torre, Siegel, Ward, & Jemal, 2015).

In Kenya, cancer is the third leading cause of death after infectious and cardiovascular diseases. In 2012, there was an estimated 37,000 new cancer cases and 28,500 cancer deaths in Kenya. According to the regional cancer registry at the Kenya Medical Research Institute (KEMRI), about 80% of the reported cancer cases have been detected at very late stages when very little can be done to cure the patient. This is mainly due to the low cognizance of cancer signs and symptoms, insufficient screening services, as well as insufficient centres for diagnostics and patients access to funding.

Cancer awareness and treatment centres in Kenya are very few and only available in urban settings. According to Makau-Barasa, et al. (2018), there are only 12 facilities for cancer treatment and diagnosis, included in the 12 there are 7 private hospitals, 2 mission hospitals and 3 public hospitals. It has 4 radiotherapy centres mostly located in urban areas. In the three public hospitals, only Kenyatta National Hospital is equipped to offer the three major cancer treatments are surgery, radiotherapy and chemotherapy. The other two public hospitals which include Coast General Hospital and Moi Teaching and Referral Hospital in Eldoret only offer chemotherapy and surgery.

Three of the private hospitals offer all the three treatment modalities while the other private hospitals only offer chemotherapy and surgery.

Some of the very essential drugs for pain management are rare to find in most public hospitals. The drugs are mostly expensive like the breast cancer drugs cost Kenya shillings 250,000 for a dose and a patient needs 18 doses, though patients receive it for free at the KNH. Patients coming from other parts of rural Kenya must travel all the way to Nairobi for cancer treatment and medication (National Cancer Control Strategy, 2018).

The Kenyan government has shown its commitment in reducing the rate of cancer death, as demonstrated by policies that they have set up such as the National Cancer Control Strategy (Kenya Ministry of Health, 2017). In addition, the Cancer Prevention and Control Act (2012) called for the formation of a National Cancer Institute of Kenya (KNCI) to advise the Cabinet Secretary, gather and analyse data researched, co-operate with partners, disseminate information, and assist treatment centres and training.

There are many other stakeholders involved in assisting the cancer situation in Kenya, such as the US National Institutes of Health (NIH) and the US Centres for Disease Control and Prevention (CDC) who have been contributing to the Kenya health sector (Topazian, et al., 2016). Six US National Cancer Institute (NCI) designated cancer centres are also partnering with research groups in Kenya, which include the Academic Model Providing Access to Healthcare (AMPATH), the Kenya Network of Cancer Organizations (KENCO), and KEMRI. The US President's Emergency Plan for AIDS Relief (PEPFAR) funding and the AMPATH Oncology and Haematology Institute have additionally provided support for cervical cancer screening and treatment program implementation (Topazian et al., 2016).

### 1.2 Problem Statement

According to Lopez-Gomez, et al. (2013) cancer has caused more deaths than HIV, TB and malaria combined. It is estimated that there 39,000 new cases every year in Kenya with more than 27,000 deaths per year. The estimated statistics is mainly from Nairobi and other urban settings in Kenya, this means there are uncounted cases in rural settings.

Though many domestic and international organizations are committed to reducing cancer mortality in Kenya, a lack of coordination exists among these stakeholders. As a result, inefficient and over-expenditure of resources leads to little progress made in the implementation of national cancer policies ( Topazian, et al., 2016).

Cancer treatment has been deemed to be expensive for instance, it would cost between Sh172,000 and Sh759,000 to treat cervical cancer without surgery here in Kenya and Sh672,000 to Sh1.25 million if one goes through an operation, according to scholars affiliated to the National Cancer Control Programme and the National Cancer Institute, Kenya. Accessing affordable health care has been a challenge for self-sponsored patients with no medical insurance cover as well as locating the different hospitals that offer cancer treatment.

## 1.3 Research Objectives

i. To review the challenges that cancer patients face when accessing healthcare and funding.

ii. To review initiatives that are currently being used to assist cancer patients in accessing healthcare and funding in Kenya.

iii. To review technologies and applications that exist to assist patients in accessing health care and funding.

iv. To design, develop and test a mobile application to assist cancer patients to access health care and funding.

v. To validate the developed mobile application.

## 1.4 Research Questions

i. What are the challenges that cancer patients face when accessing health care and funding?

ii. Which initiatives are currently being used to assist cancer patients in accessing health care and funding in Kenya?

iii. What technologies and applications exist in assisting patients to access health care and funding?

iv. How can the mobile application assist cancer patients in accessing health care and funding be designed, developed and tested?

v. How can the mobile application be validated?

## 1.5 Justification of the Study

The number of cancer patients has been on the increase in Kenya. The mortality rate being at 40,000 patients every year. There is therefore, a need to assist patients in accessing health care and funding as well as giving awareness to the public on cancer screening for early detection and treatment.

There are many stakeholders who have joined forces to assist cancer patients and thus the mobile application developed should assist to coordinate the stakeholders and the cancer patients as well provide a platform where the cancer patients can be tracked and assisted.

**1.6 Scope of the Study**

The research focused mainly on assisting cancer patients to access health care and funding. The mobile application was developed on the Android platform. The Android application catered for users with smartphones. A web application was also designed to monitor, manage the application and receive the different requests by the patient.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.1 Introduction

This chapter will discuss the literature that exist around the research study. The researcher will elaborate the challenges faced by cancer patients and the initiatives to assist them. The existing technologies and applications to assist in accessing health care and funding as well as the gaps that exist in the technologies will be discussed.

## 2.2 Challenges Faced by Cancer Patients in Accessing Health Care and Funding

### 2.2.1 Challenges in Accessing Health Care in Kenya

The major stakeholders for the provision of health care is the government which provides accessible and affordable treatment. The Ministry of Health and other government institutions represents the public sector. The private sector includes the private for profit and private for not profit. There also missionary hospitals owned by churches and other non-governmental organisations which complement the efforts of the government (Wanjau, Muiruri, & Ayodo, 2012).

According to Makau-Barasa et al. (2018) there are three public hospitals that provides cancer treatment and screening in Kenya, this is the Kenyatta National Hospital, the Moi Referral and Teaching Hospital and the Coast General Hospital. Among the public facilities listed, only Kenyatta National Hospital (KNH) is equipped to provide the three major cancer treatment modalities: surgery, radiotherapy, and systemic therapy (chemotherapy), the other two only provide surgery and systemic therapy. Most patients with cancer who cannot afford private hospitals are unable to access the two referral hospitals due to funds, distance and long queues.

There are seven private hospitals and two mission hospitals that also provide cancer screening and treatment and are mainly located near urban centres. Three of the private hospitals mainly the Nairobi Hospital, MP Shah and Aga Khan provide all the three cancer treatment modalities while the other hospitals only provide surgery and systemic therapy (Makau-Barasa et al., 2018).
The annual incidence of cancer is estimated to be about 40,000 cases and the annual mortality to be over 22,000. The estimated cases of patients mainly obtained from the cancer registries are all not able to access the health care they need. The ratio of cancer patients to the health care facilities is very low (Topazian et al., 2016).

### 2.2.2 Challenges in Accessing Funds

Most Kenyans live on just a few US dollars a day, based on figures from the government's latest economic survey. With an estimated 75% of the population not covered by a public, private or community health insurance scheme, paying for basic healthcare is already a challenge and paying for treatment for a life-threatening disease is even more of a stretch. According to the World Bank, nearly one million Kenyans fall below the poverty line because of health care related expenditures (Ramrayka, 2018).

## 2.3 Initiatives to Assist Cancer Patients in Accessing Health Care and Funding

### 2.3.1 Initiatives by the Kenyan Government

**National Health Insurance Fund**

NHIF membership is mandatory for all Kenyan residents who are employed and have attained the age of 18 years. There is also voluntary membership for residents who have attained the age of 18 years with no upper limit of age or limitations on any pre-existing conditions (Barasa, Mwaura, Rogo & Andrawes, 2017).

In 2015, NHIF announced an outpatient cover and heightened assistance for sicknesses such as cancer after raising the minimum contribution of workers from Ksh 320 to Ksh 500 and Ksh 1,700 monthly. The cancer package entitles them to chemotherapy, radiotherapy, CT and MRI scans as well as monthly clinic check-ups (Jamah & Adhiambo, 2016).

The national health insurer's cover for chemotherapy is capped at Sh600,000 per beneficiary, covering six chemo cycles that are each administered monthly. Radiotherapy cover is capped at Sh70,000 for 20 sessions, according to NHIF officials (Jamah & Adhiambo, 2016).

There are private hospitals which offer cancer treatment and accept the NHIF cover thus easing the pressure on government hospitals such as Kenyatta National Hospital which had been deemed affordable and had a high number of patients.

**Universal Healthcare Plan**

A pilot programme has been launched to ensure that the Universal Healthcare Plan can be initiated all over the country (Merab, 2018). The Universal Healthcare plan is part of the big four agenda by His Excellency President Uhuru Kenyatta that is to guide the development agenda of the country in the period 2018-2022 (Kirii et al., 2018).

**Public-Private Partnership**

The innovative partnership between the Kenyan government through the Ministry of Health and Roche Kenya was aimed at improving access to timely and precise diagnostic services, tailor made for cancer treatment to ensure cancer therapy is made more effective (Ramrayka, 2018).

According to Ramrayka (2018), Roche Kenya and the Kenyan government had a memorandum of understanding to jointly cover the HER2-positive treatment cost at public institutions to bridge the gap until NHIF or the other government funding is possible.

**Cancer Policies**

The Kenya Ministry of Health has made efforts in reducing the cancer mortality by enacting policies such as the National Cancer Control Strategy, 2017-2022.The National Cancer Control Strategy has been designed to guide the country outline interventions towards cancer prevention and control based on the current cancer burden, risk factors prevalence and available resources.

The National Cancer Control Strategy 2017-2022 provides a strategic framework to direct the approach used to reduce the incidence, morbidity and mortality of cancer and improve the quality of life of cancer patients. The main features of this policy include focusing on the whole cancer care process from prevention to palliation. The document also boosts coordination of cancer prevention and control activities thus limiting duplication of efforts. It also outlines the guiding policy for all stakeholders thus assist in effective and well-organized monitoring and evaluation of cancer interventions.

**Cancer Registries**

Nairobi Cancer Registry was enacted in the year 2001 after discussions between the National Cancer Institute– Office of International Affairs, International Agency for Research on Cancer , Ministry of Health and Kenya Medical Research Institute It is located at the Centre for Clinical Research (CCR), KEMRI headquarters, Nairobi (Korir & Mutuma, 2006).

Cancer registries was deemed to be important in informing the control activities that stakeholders in the health sector require to put in place in the regions. The evidence of the cancer population as obtained in the registries would assist in quantifying and advocating for funds needed to withstand, improve and scale up high quality cancer registration in Kenya (Morgan et al., 2018).

According to the Ministry of Health,Kenya (2017) there are cancer registries in Eldoret, Nairobi and Kisumu. There are strategies underway to start new cancer registries by the Ministry of Health despite lack of funding and other institutionalization challenges.

### *2.3.2 Non-Governmental Organisations and Other Stakeholders*

The National Cancer Institute of Kenya (NCI-K) is a statutory body with an overall mandate to coordinate and centralize all activities related to cancer prevention and control in Kenya thus ensuring there is equitable and efficient allocation and utilisation of resources in the cancer control (Topazian et al., 2016).

The Kenya Cancer Association is a not-for-profit organization whose activities are geared towards achieving a Kenya free of cancer. Every year, KENCASA, with the empowering of the American Cancer Society, pulls its funds together to hold the Relay for Life event. The Relay for Life is the largest global fundraising movement which, through a local cancer organization in each partnering country, works to promote community cancer awareness and to advocate for cancer control, care, policy, research and patient support (Pendegrast, 2014).

The American Cancer Society (ACS) and Clinton Health Access Initiative (CHAI) have assisted Kenya to enter a deal with two international drug manufacturers, Pfizer and Cipla. The deal was intended to see Kenya purchase up to 16 cancer drugs at half the market price thus increasing access to life-saving cancer treatment including chemotherapies (Wanjohi, 2017).

The AMPATH Oncology Institute was formed in 2008 in assisting the cancer burden in Kenya, it has built a system of cancer treatment and prevention. In 2016, the organisation opened Chandria Cancer and Chronic Disease Centre at Moi Teaching and Referral Hospital in Kenya, which serves as a learning institute to train the next generation of Kenyan caregivers and provides a home for robust research and care. The organisation has also assisted the Kenyan Ministry of Health in drafting the Kenya National Cancer Control Strategy, which assists to formulate health policies and solutions to the current health challenges (Morgan et al., 2018).

## 2.4 Existing Technologies and Applications that Assist in Accessing Health Care and Funding

### *2.4.1 M-tiba*

M-TIBA is a mobile digital platform for comprehensive healthcare that directly connects patients, providers, and payers such as family members, health insurers or donor agencies. It empowers consumers, advances their financial protection, provides better quality of care and generates local and international financing for health. M-TIBA has enabled people to save, send, receive and pay money for medical treatment through a mobile health wallet on their mobile phones. It's a closed loop with restricted funds that are spent only on selected healthcare providers (Morgan & Churchill, 2018). M-tiba has been developed both in Android and USSD platforms.

### 2.4.2 WelTel

WelTel uses a two-way SMS-based messaging to monitor and support antiretroviral (ARV) therapy in Kenya. WelTel's SMS communications are estimated to have raised ARV patients' adherence to their treatment schedules by a quarter (Lester et al., 2010) .

### 2.4.3 ChildCount +

ChildCount+ is a mHealth platform developed by the Millennium Villages Project aimed at empowering communities to improve child survival and maternal health. ChildCount uses SMS text messages to facilitate and coordinate the activities of community-based health care providers, usually community health care workers (CHWs). Using any standard phone, CHWs can use text messages to register patients and report their health status to a central web dashboard that provides a real-time view of the health of a community.  Powerful messaging features help facilitate communication between the members of the health system and an automated alert system helps reduce gaps in treatment (Qiang, Yamamichi, Hausman, Altman & Unit, 2011).

 According to (Qiang et al., 2011) ChildCount+ system supports the delivery of Community-based management of acute malnutrition programmes, home-based testing for malaria using Rapid Diagnostic Test Kit as well as immediate dispersal of treatments, home based treatment of children with diarrhoea and it also supports maternal health.

### 2.4.4 Changamka

A fully digital health savings account, based on a smart card, that can be used to pay for outpatient services within a network of healthcare providers. The firm receives about 20 percent of the sale price of each card; new cards include credits for a medical consultation, a lab test, and a prescription This allows users to deposit funds into health savings accounts, using services such as M-PESA, to pay for health services (Qiang et al., 2011).

### 2.4.5 Clinton Health Access Initiative / Hewlett Packard / Kenya Ministry of Public Health and Sanitation – Early Infant Diagnosis of HIV

This system accelerates early-infant diagnosis (EID) of HIV through an SMS-based system. Hewlett Packard has developed a custom database application that uses cloud computing to capture, manage and return infant HIV test results in one to two days, a significant improvement from the previous paper-based system that took over one month (Peeling, 2015).

### 2.4.6 MedAfrica

This mhealth solution is available for smart phones and feature phones. The platform aggregates information from many sources. So far, it supplies first-aid recommendations from local hospitals, and health alerts and updates from other hospitals, as well as lists of doctors and dentists (Talbot, 2011).

### 2.4.7 Sema Doc/Hello Doctor

Sema Doc operates on the Safaricom network with the approval of the Ministry of Health and is the only company in Sub-Saharan Africa licensed to-date to provide tele-medicine on a commercial basis (Ngumi, 2016).

Sema Doc is available as a monthly subscription service for only 300 Kenya Shillings payable via m-Pesa or m-Shwari. Users subscribe to the service by dialling a USSD short-code on a Safaricom line, to access registration the first time, and to access the service options thereafter. The subscription package consists of 24/7 mobile access to medical doctors through voice communication and text messaging, a health account dedicated to help you save for medical expenses, access to instant health loans, a Ksh. 5,000 Hospital Cash Benefit; and access to daily health tips (Mukisa & Ochieng, 2015).

## 2.5 Health Care Funding in Developed Countries

### 2.5.1 United State of America Health Plans

The largest government health insurance plan include the Medicare, this funds health care for the elderly, the disabled, and people under long-term treatment such as dialysis, the other larger health insurance plan is the Medicaid, which funds health care for a category of people who are living below the poverty level or have disabilities (Randall , Tianxu , & Lusco, 2014).

State Children's Health Insurance Program is also another government program that was designed to provide a health cover for uninsured children when their family's income was below average but too high to qualify for Medicaid (Shields, 2007).

Children and Youth with Special Health Care Needs: This program coordinates funding and resources to provide care to people with special health needs Veterans Health Administration is a government operated health care that provides comprehensive health care plan to eligible military veterans (Randall , Tianxu , & Lusco, 2014).

Indian Health Service is a system of government hospitals and clinics that provides health services to about two million American Indians and Alaskan natives living on or near a reservation1 (Randall , Tianxu , & Lusco, 2014).

Refugee Health Promotion Program: This program provides short-term health insurance to newly arrived refugees in collaboration with the U.S. Department of Health and Human Services Administration for Children & Families Office of Refugee Resettlement (Randall , Tianxu , & Lusco, 2014).

### 2.5.2 Israel

Israel's' NHI system automatically covers all citizens and permanent residents apart from soldiers, who are covered directly by the army. The cover is funded primarily through a special income-related health tax in combination with the government revenues (Rosen, Waitzberg, & Merkur, 2015)

Employers are required to enroll any foreign workers in private insurance programs, whose range of benefits is similar to that of NHI. Private insurance is also available, on an optional basis, for tourists and business travelers. However, there are people living in Israel with no health insurance cover this includes undocumented migrants who are not working. Several health plans are made accessible to all entities regardless of their legal or covered status. These include emergency care, preventive mother and child health services, and treatment of tuberculosis, HIV/AIDS, and other sexually transmitted infections (Rosen, Waitzberg, & Merkur, 2015).

### 2.5.3 Australia

The federal government mainly offers funding and indirect care to the states and health professions, sponsoring primary-care providers over the Medicare Benefits Scheme, the Pharmaceutical Benefits Scheme and providing funds for state services. The states have most of the responsibility for public hospitals, ambulance services, public dental care, community health services, and mental health care. They subsidise their own funding in addition to that provided by federal government. The public health insurance program provides free or subsidise access to Australian citizens, resident with a permanent visa, and New Zealand citizens with proof of identity (Mossialoa, Djordjeric, Osborn, & Sarnak, 2016).

Private Health Insurance is also readily available and offers more choice of hospitals and faster access to emergency services. Government policy encourages their citizens to take up private health insurance schemes for certain income earners and there's a penalty fee for not having a PHI. Private health insurance covers hospital care, general treatment, or ambulance services.

### 2.5.4 United Kingdom

The UK has a government-sponsored universal healthcare system called the National Health Service. The NHS consists of a series of publicly funded healthcare systems in the UK. It includes the National Health Services England, NHS Scotland, NHS Wales and Health and Social Care in

Northern Ireland. Citizens are entitled to healthcare under this system but have the option to buy private health insurance as well. The NHS Plan promises more power and information for patients, more hospitals and beds, more doctors and nurses, significantly shorter waiting times for appointments, improved healthcare for older patients, and tougher standards for NHS organizations (Chang, Peysakhovick, Wang, & Zhu, 2012).

### *2.5.5 Netherlands*

In 2006 the Health Insurance Act entered into force, under which all residents of the Netherlands are entitled to a comprehensive basic health insurance package. This act is implemented by private, competitive health insurers and healthcare providers. The healthcare system in the Netherlands is divided into 3 sectors or compartments, which are long-term care for chronic conditions, basic and essential medical care from GP visits to short-term hospital stays and specialist appointments or procedures and supplementary care, for example dental work, physiotherapy, cosmetic procedures (Healthcare in the Netherlands, 2016).

## 2.6 Gaps and Limitation of Existing Technologies

SMS based mhealth solutions that are toll free have not been fully embraced by mobile operators due to lack of understanding of their business models. Some mhealth solutions are at the prototype stage and require funding to be fully adopted and widely spread across the country. Most applications need user subscription and have not been networked with donor funding to subsidize the cost of the use of the mhealth solutions.

# CHAPTER THREE

# RESEARCH METHODOLOGY

### 3.1 Introduction

The purpose of this research is to assist cancer patients in accessing healthcare and funding with the use of a mobile application. This chapter will elaborate the research methodology that was used and the techniques used to analyse the data.

### 3.2 Software Development Methodology

Agile software methodology was used by the research as shown in the Figure 3.1. Agile development motivates adaptive planning, evolutionary development and early delivery of value to the stakeholders. The software delivered gives value to the stakeholders.

Agile methodologies have been considered lightweight in that they thrive to impose a minimum process and overhead within the development lifecycle. In any Agile development project, there is an emphasis on empowering teams through collective decision-making.
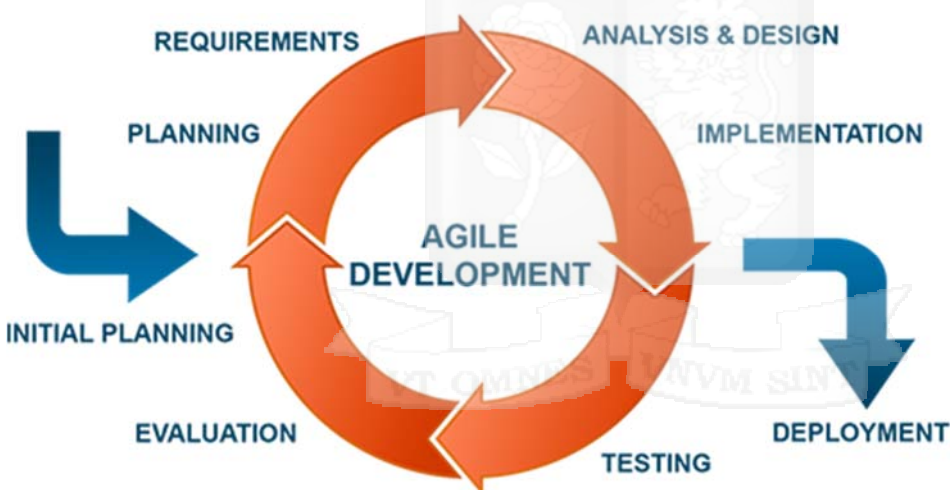


Figure 3.1 Agile Methodology (Quest Infosense, 2013)

### 3.2.1 Planning Phase

This is the first phase of the research methodology; the researcher has outlined what is needed for the solution to be developed. The scope of the project was defined and broken down in a comprehendible manner.

### 3.2.2 Requirement Analysis Phase

This is the second phase of the research methodology, it involves gathering the requirements of the solution to be developed. The population selected for the research was 50 because of the high level of similarities in responses that was expected from the population as they were either cancer patients, stakeholders or cancer survivors. Simple random sampling was used by the researcher to

identify the population for the research as it is simple to implement and analyse (Simple Random Sampling, 2019).The researcher issued questionnaires to 50 respondents who were reached out to at a Cancer palliative care centre in Nairobi as there are frequent visits by cancer patients and survivors as well as random cancer patients and few stakeholders. The users were given printed questionnaires and assisted on understanding the questions based on their literacy level. Data collected was analysed using google analytics in order to get meaningful and interpretable results from the survey. Observation was also used to inform the researcher further. This phase assisted the researcher to know the needs of the users that the mobile application will meet.

### 3.2.3 Design Phase

Object Oriented Analysis was used in this research. This is to ensure that the user requirements are captured profoundly. Unified Modelling Language (UML) was used as the modelling language as it useful in Object Oriented Analysis and Design (OOAD) to assist the researcher in modelling analysis and design diagrams (Mukherjee, 2016).

Use Case diagram was used to show the interaction between the system users to the system to be developed. System Sequence diagram was also used to show how users interact, receive feedback and messages to and from the solution (Jakimi & Koutbi, 2009).

The Entity Relationship Diagram was also utilised to model the database. This showed the tables, attributes and relationships. The Database Schema modelled the table structure showing fields, data types and descriptions.

Wireframes were used to illustrate process flows of both the web backend and the mobile application. This was designed using Balsamiq software (https://balsamiq.com/) as it is quite easy to understand and use.

### 3.2.4 Implementation Phase

An Android mobile application was designed and developed using Android Studio because it has most users (Maina, 2017). A backend web application was also developed that integrated with the Android application, this was designed using HTML5, CSS3, PHP and MySQL was used for the database.

### 3.2.5 Evaluation and Testing Phase

Firstly, compatibility testing was done on the mobile application in the various Android version platforms using an online open source software known as Geany Motion Android Emulator (https://www.genymotion.com/) as it simple and openly available for mobile application developers and testers.

The next test done was usability testing, a sample of the targeted users tested the mobile application and gave their response on how easy or difficult the solution was. To achieve this, the

prototype developed was issued to the respondents alongside a questionnaire that was used to capture their response.

Validation testing was also done to validate whether the mobile application solved the problems that cancer patients have while accessing healthcare and funding. A questionnaire was designed and shared with a few respondents for them to test the application and give their feedback on its usefulness.

### 3.3 Ethical Considerations

The researcher took into consideration some ethical issues when collecting data from the respondents. The university issued the researcher with a letter to identify her as their student in order to get the needed assistance to conduct the research. The researcher informed the respondents the purpose of the research being undertaken and assure them that information received from the questionnaires was confidential. The researcher was not biased on gender or disposed to political interests. The information to be gathered was treated with confidentiality and complete anonymity observed.

### 3.4 Conclusion

This chapter elaborates the research methodology to be used in developing the solution as guided by the research questions in chapter one. Agile methodology was used and thus sets the pace and standard for the next chapters.
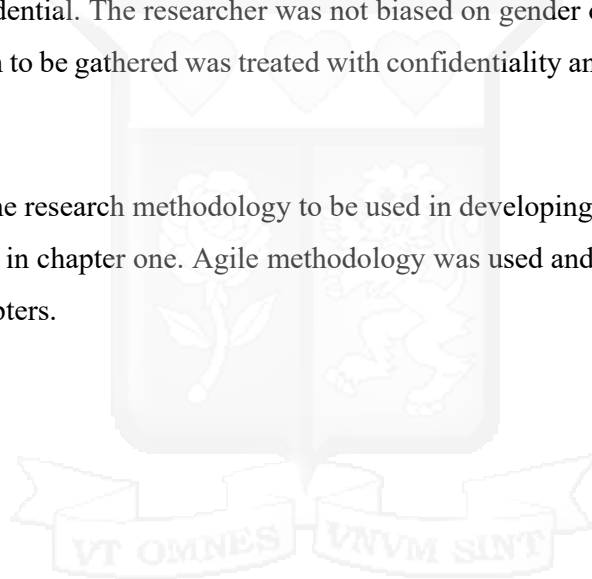
# CHAPTER FOUR

# SYSTEM DESIGN AND ARCHITECTURE

## 4.1 Introduction

This chapter elaborates the system design and architecture of the proposed solution as derived from various data sources. It also encompasses the presentation of use case diagrams, context diagrams, sequence diagrams, entity relationship diagram and wireframes.

## 4.2 Requirements Analysis

The requirements of the system were collected using the questionnaire at Appendix A and analysed using google analytics. The total number of respondents who participated in the survey was 50.

**Smart Phone Users**

90 % of the respondents indicated that they owned a smart phone while 10% of the potential users did not own one.
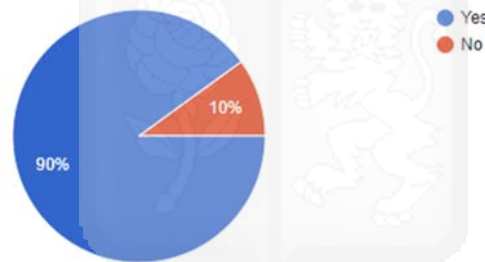


Figure 4.1 Smart Phone Users

**Type of Smart Phone**

The respondents who indicated to have smartphone responded regarding the type of smart phone they possessed.86.7% of the potential users indicated to own an Android phone while 13.3% indicated to have iOS smart phone.
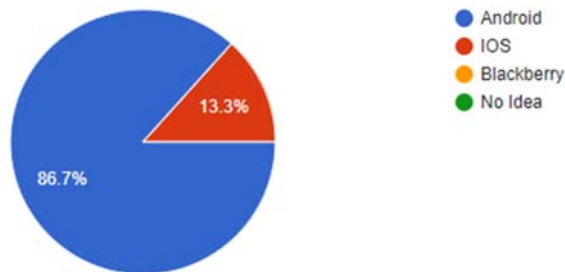


Figure 4.2 Type of Smart Phone

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**Financing of Medical Bill**

The respondents indicated on how they mostly finance their hospital bill. 48% of the respondents indicated that they relied on well wishes and family members, 32% indicated that they relied on health insurance while 20% used their personal savings to assist them in financing their medical bill.
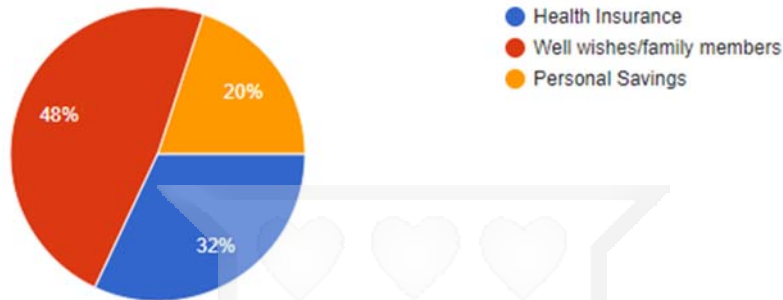


Figure 4.3 Medical Bill Financing

**Health Challenges**

Figure 4.4 shows the respondents response on the challenges they face when accessing health care. 48% indicated lack of funds, 36% indicated poor health service delivery,10% indicated distant location of health care facility and 6% indicated long queues as the major challenge they experience.
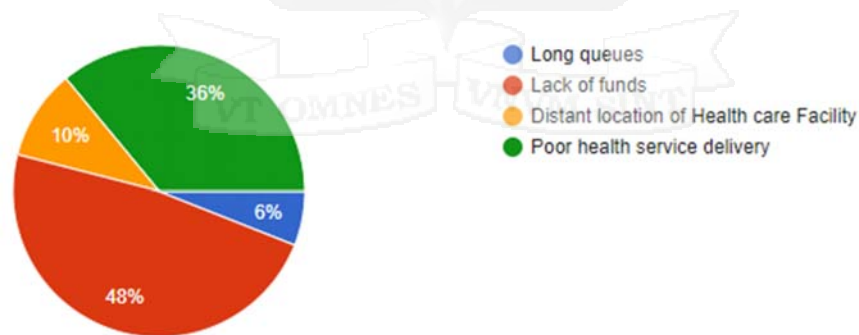


Figure 4.4 Health Challenges

### *4.2.1 Functional Requirements*

This outlines the requirements of the system that the implemented solution should perform in order to achieve the objectives of the research, they include:

i.    The application should register cancer patients.

ii.   It should provide a list of health facilities that offer cancer treatment and their directions as well as a capability to request for appointment for treatment.

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iii. It should provide a list of oncology doctors and their contacts as well as request for appointment from them.

iv. It should enable a user to request for funding.

v. It should alert the patient on the scheduled appointments from either the health facility or the doctor.

vi. The system should enable the health facility representative, doctors and donors to view the requests forwarded to them.

### 4.2.2 Non-Functional Requirements

i. Usability – the system interface should be easy to use

ii. Integrity – the system being data oriented, it should ensure that the data collected is confidential and only to be used for the intended purpose.

iii. Performance and response time should be acceptable while performing its functions.

## 4.3 System Design

This segment explains the design and architecture of the system to be implemented. The UML diagrams have been used to design the solution and show the user interaction with the system.

### 4.3.1 System Architecture

Figure 4.5 shows the system architecture of the solution.
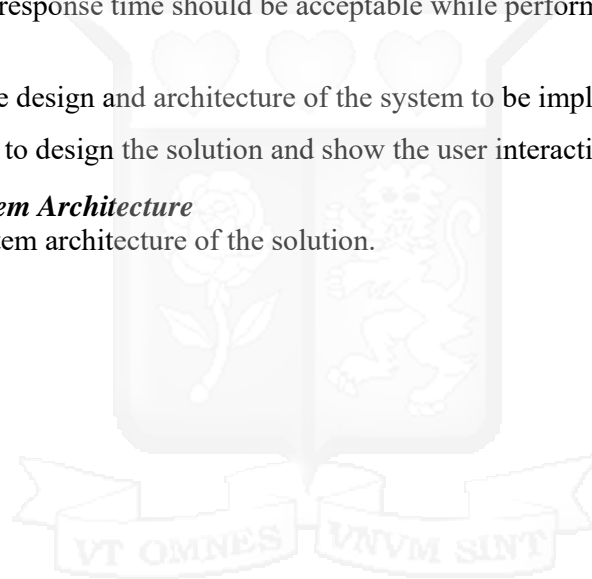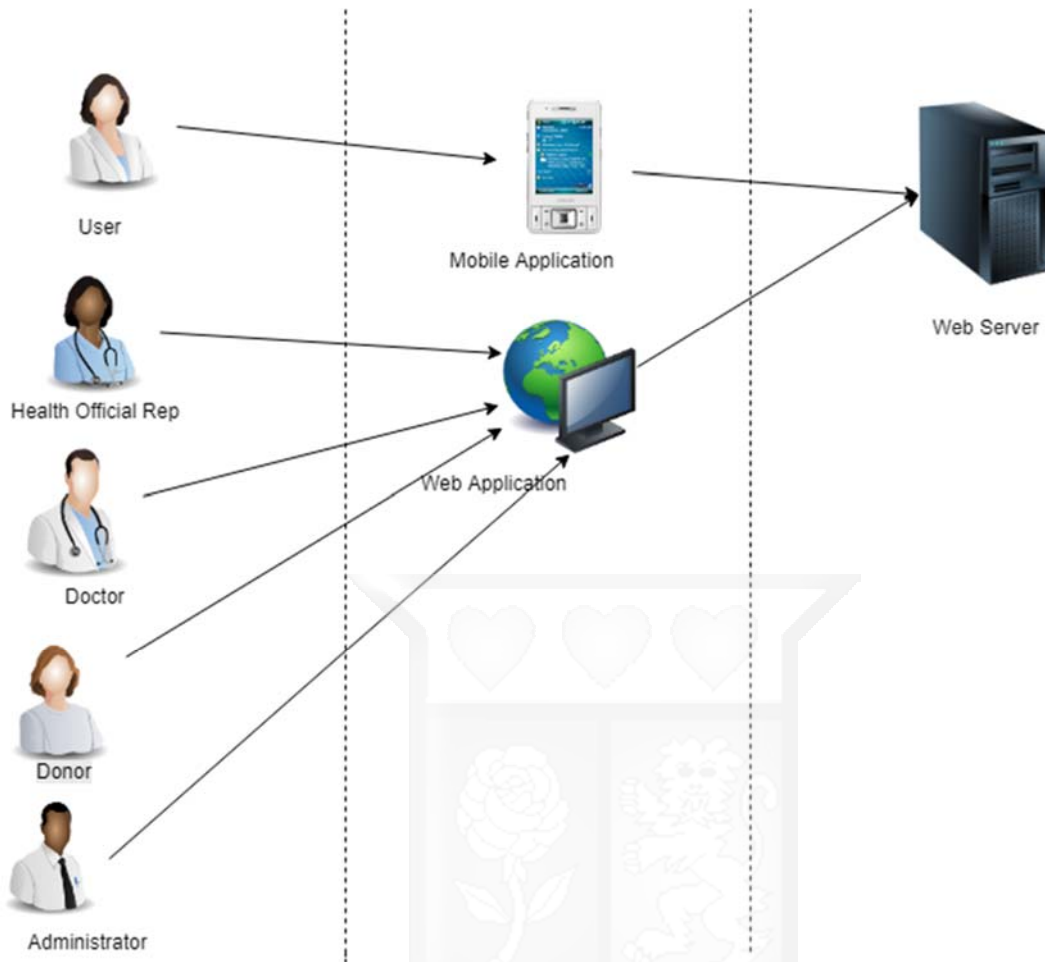
Figure 4.5 System Architecture

### 4.3.2 Use Case diagram and Description

Figure 4.6 shows the use case diagram that shows the interaction that the users have in the system. The actors have been identified as patients, health facility representative, donors, doctors and system administrators. The donors, doctors, health facility representative and system administrators interact with the web application while the patient interact with the mobile application.
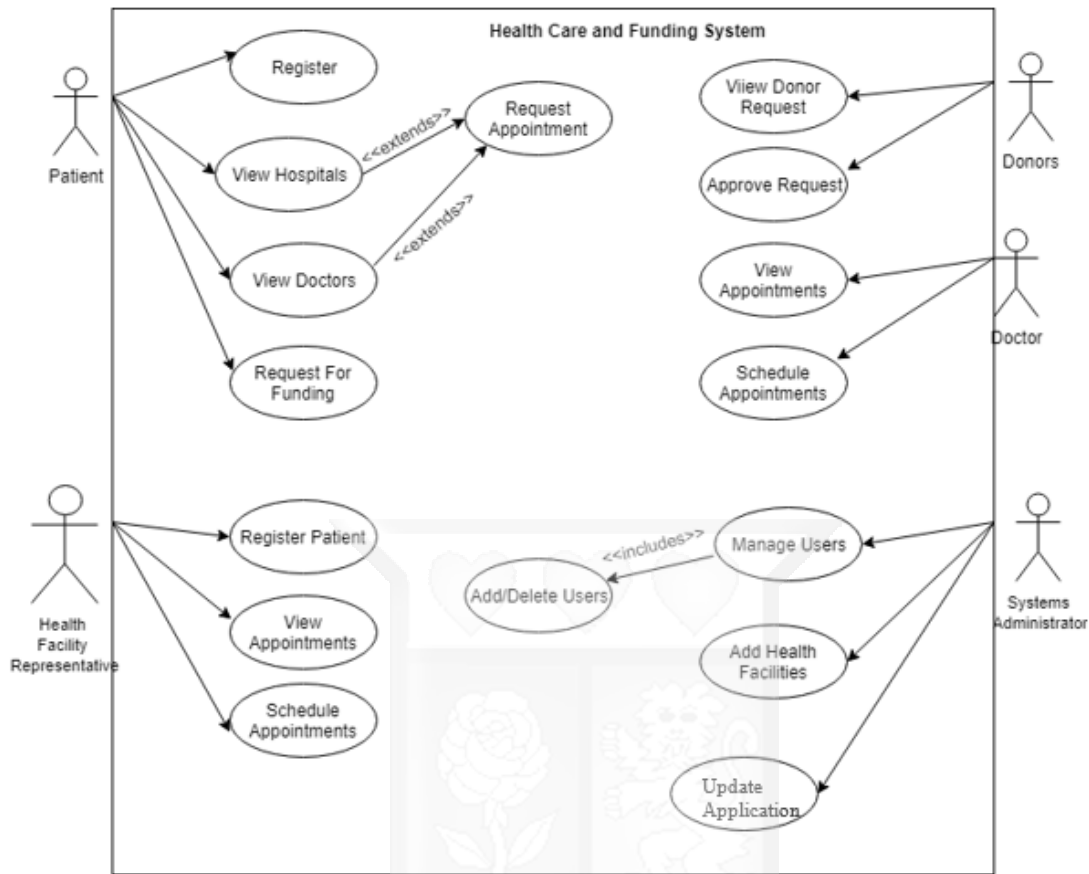
Figure 4.6 Use Case Diagram

**Use Case Description**

Use case description is seen in the subsequent tables. This shows how the users perform the tasks as they interact with the application. Table 4.1 shows how the users register to the application before they can access the features of the application. Table 4.2, Table 4.3, Table 4.4 and Table 4.5 describe the tasks performed by the hospital official and doctor when scheduling and approving the requests made by the cancer patients. Table 4.6 shows the donors tasks in approving donation request made and Table 4.7 describes the administrator in managing the system users.

Table 4.1 Register Patient Use Case Description

| Use Case 1 | Register Patient |
|---|---|
| Description: | Describes how patients register to the application |
| Primary Actors: | Patient and Health Official representative |

| Precondition: | The user must be a cancer patient or assisting a cancer patient to register |
|---|---|
| Post condition: | The user must be logged into the application |
| **Typical case of Events** | **System Response** |
| **Actor Response** | 1.Display the registration form |
| 1.Select user registration | 2. Confirmation message is displayed |
| 2.Submit registration details | |
| **Alternative flow** | |
| User registration is not submitted | |

Table 4.2 Hospital Appointment Request Use Case Description

| Use Case 2 | View and request hospital appointment |
|---|---|
| Description: | Describes how hospitals offering cancer care are displayed |
| Primary Actors: | Patient and Health Official representative |
| Precondition: | Patient must have been registered successfully to the app |
| Post condition: | The user must be logged into the application |
| **Typical case of Events** | **System Response** |
| **Actor Response** | 1.Display hospitals with their facilities |
| 1.Select a hospital and view facilities | 2. Display message notification for awaiting approval |
| 2. Request an appointment | |
| **Alternative flow** | |
| Appointment not submitted | |

Table 4.3 Doctors Appointment Request

| Use Case 3 | View and request doctor's appointment |
|---|---|
| Description: | Describes how patients view and request doctor's appointment |
| Primary Actors: | Patient and Health Official representative |

| Precondition: | Patient must have been registered successfully to the app |
| --- | --- |
| Post condition: | The user must be logged into the application |
| **Typical case of Events** | |
| **Actor Response** | **System Response** |
| 1. Select a speciality and choose a doctor. 2.Request an appointment | 1.Display doctors with their specialties 2. Display message notification for awaiting doctor's approval |
| **Alternative flow** Appointment not submitted | |

Table 4.4 Request for Funding Use Case Description

| Use Case 4 | Request for funding |
| --- | --- |
| Description: | Describes how users request for the funding for their medical treatment |
| Primary Actors: | Patient and Health Official representative |
| Precondition: | Patient must have been registered successfully to the app |
| Post condition: | The user must be logged into the application |
| **Typical case of Events** | |
| **Actor Response** | **System Response** |
| 1. User must type in the budget of their treatment. 2. Submit the budget. | 1. Display the budget typed 2. Display message notification for budget submitted. |
| **Alternative flow** Budget not submitted | |

Table 4.5 Schedule Appointments Use Case Description

| Use Case 5 | Schedule Appointments |
| --- | --- |
| Description: | Describes how the doctor or the Hospital representative will view and schedule appointments |

| Primary Actors: | Doctor and Health Official representative |
|---|---|
| Precondition: | Patient must have been submitted a request for appointment |
| Post condition: | The user must be logged into the web application |
| **Typical case of Events** | |
| **Actor Response** | **System Response** |
| 1. User views the appointment request. | 1. Displays the appointment request. |
| 2. Schedule appointments for the patient. | 2. Display message notification for scheduled appointments |
| **Alternative flow** | |

Table 4.6 Donor Request Use Case Description

| **Use Case 5** | Donor Request |
|---|---|
| Description: | Describes how the donor view the requests and approves or disapproves |
| Primary Actors: | Donor |
| Precondition: | Patient must have been submitted a request for funding |
| Post condition: | The user must be logged into the web application |
| **Typical case of Events** | **System Response** |
| **Actor Response** | 1. Displays the requests. |
| 1. User views the funding requests | 2. Display message notification for saved feedback |
| 2. Approve or disapprove requests | |
| **Alternative flow** | |

Table 4.7 Manage Users Use Case Description

| **Use Case 5** | Manage Users |
|---|---|
| Description: | Describes how the system administrator adds, updates and deletes system users |
| Primary Actors: | User must have administrative privileges |

| Precondition: | User must have the user's details |
|---|---|
| Post condition: | The user must be logged into the web application |
| **Typical case of Events** | **System Response** |
| **Actor Response** | 1. Users added to the system |
| 1. Administrator adds users | 2. Users updated or deleted message |
| 2. Administrator updates and deletes users | notification is displayed |
| **Alternative flow** | |
| User not added to the system | |

### 4.3.3 Context Diagram

Figure 4.7 shows the context diagram. This shows the relationship that the system has with external entities. External entities include the patient, system administrator, doctor, donor and health care official representative. Patients have to register through the mobile application to be able assisted to access health care and request for funding. The doctors and health official representative check the different requests made to them for approval and scheduling.
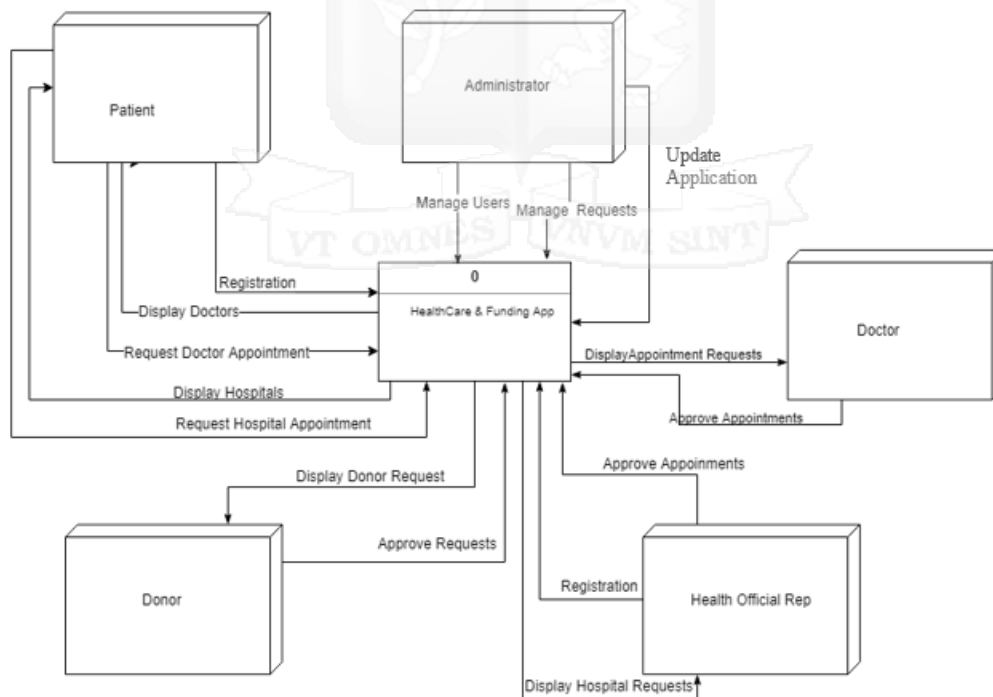


Figure 4.7 Context Diagram

### *4.3.4 Sequence Diagram*

Figure 4.8 and Figure 4.9 shows the sequence diagram which illustrates the interaction of the users with the system. Once the application has been installed, the users can interact with the system. The sequence diagram shows the event that take place and the feedback response obtained from the system to the user.
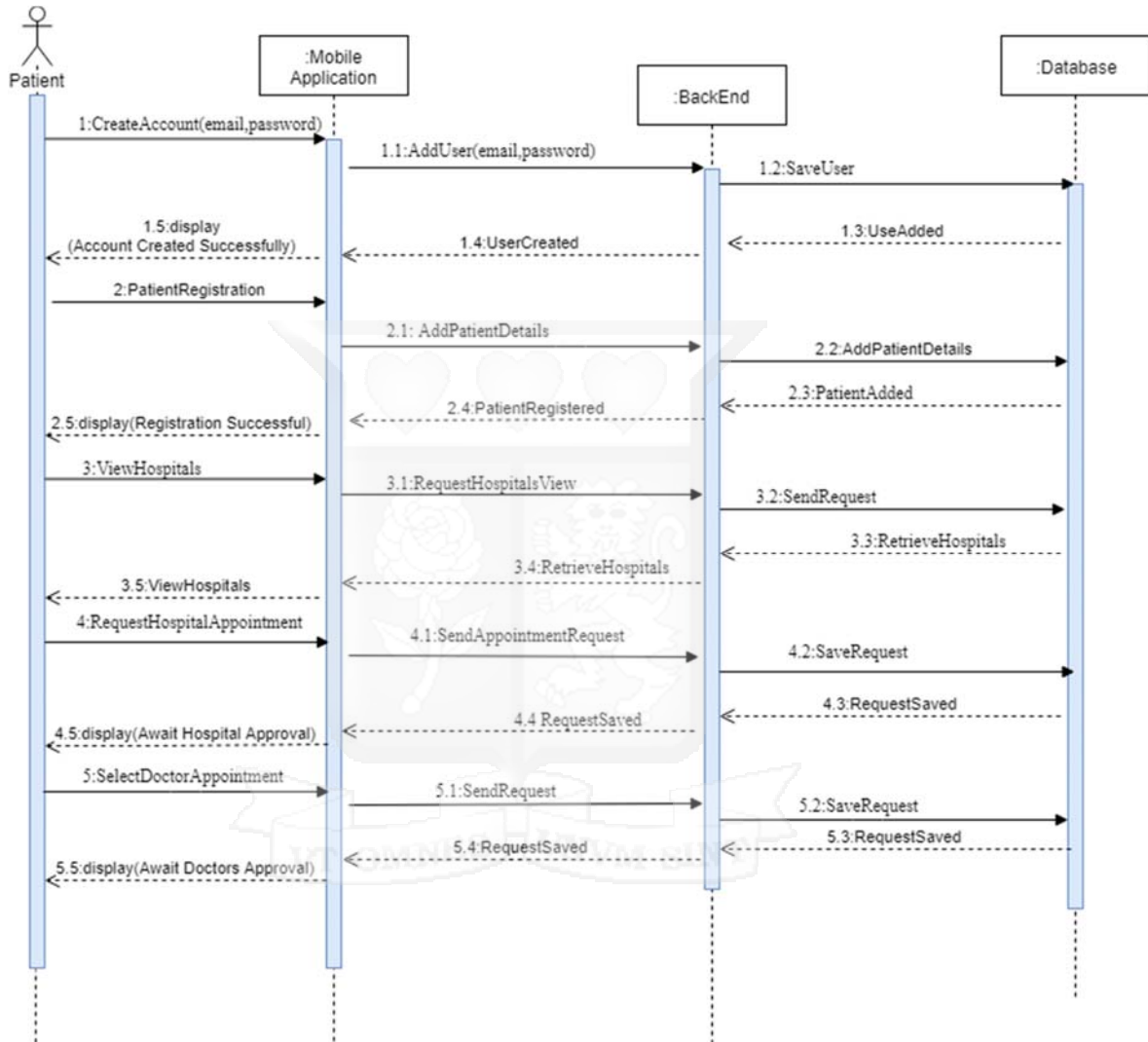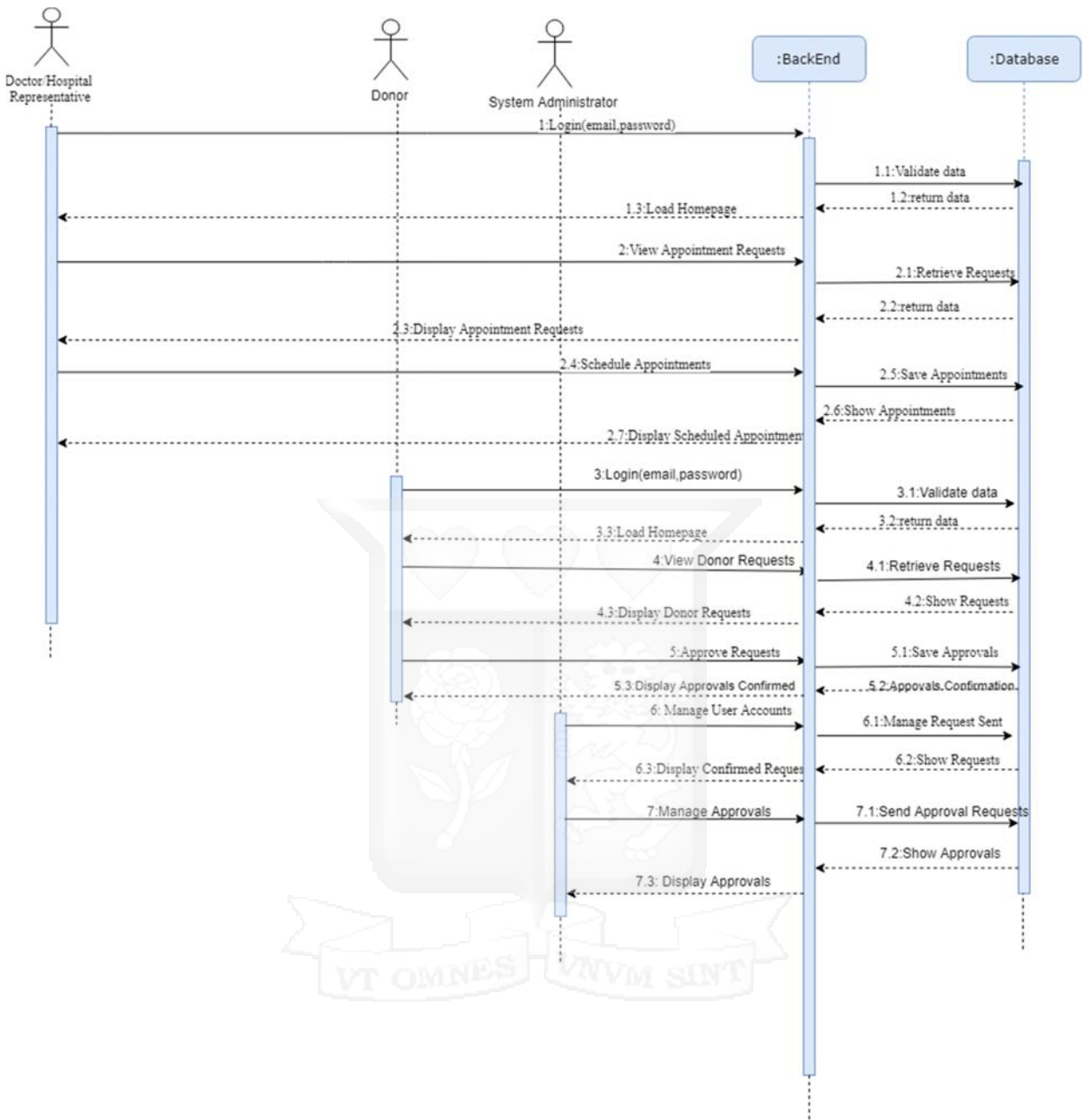


Figure 4.8 Sequence Diagram

Figure 4.9 Sequence Diagram

### 4.3.5 Entity Relationship Diagram

Figure 4.10, demonstrates the conceptual view of the systems database as well as how the tables relate to each other. The mobile and web application link to the same database, thus the database tables and their relationships are shown.
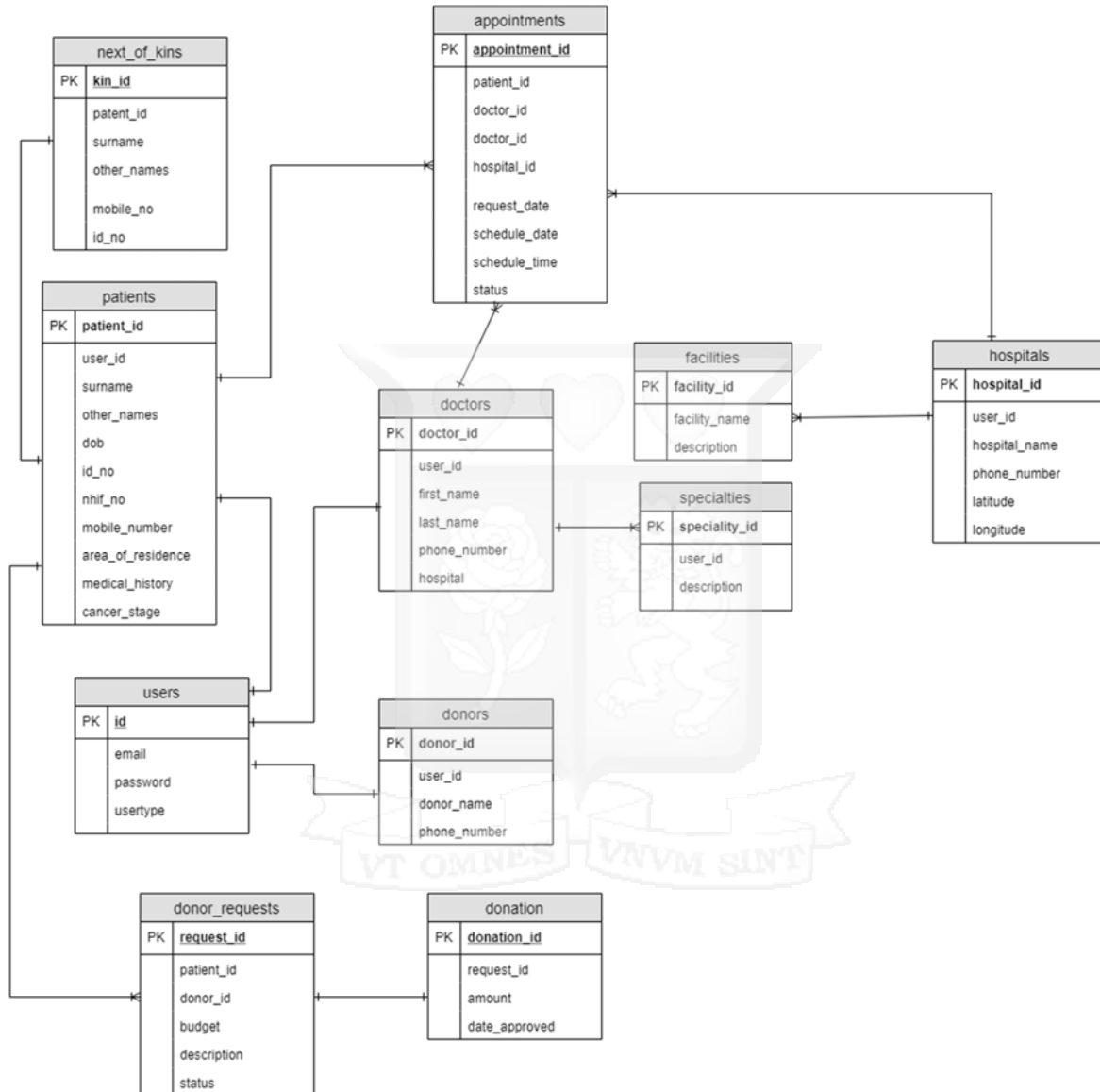


Figure 4.10 Entity Relationship Diagram

### 4.3.6 Database Schema

The Tables demonstrate the entities and the fields as well as their corresponding primary and foreign keys as integrated in the database design. The main tables are demonstrated while the other Tables can be found in Appendix C.

Table 4.8 shows the patients table, all patient details upon registration are captured here.

Table 4.8 Patients Table

| Column Name | Data Type | Index |
|---|---|---|
| patient_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| other_names | varchar(255) | |
| Dob | varchar(255) | |
| id_no | varchar(255) | |
| nhif_no | varchar(255) | |
| mobile_number | varchar(255) | |
| area_of_residence | varchar(255) | |
| medical_history | Text | |
| cancer_stage | varchar(255) | |

Table 4.9 shows the Next_of_Kins Table which holds the details of the patients next of kin.

Table 4.9 Next_of_Kins Table

| Column Name | Data Type | Index |
|---|---|---|
| kin_id | int(11) | Primary key |
| patient_id | int(11) | Foreign key |
| surname | varchar(255) | |
| other_names | varchar(255) | |
| mobile_no | varchar(255) | |
| id_no | varchar(255) | |

Table 4.10 shows the Donor Requests table that holds the donor requests.

Table 4.10 Donor Requests Table

| Column Name | Data Type | Index |
|---|---|---|
| request_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| donor_id | int(11) | Foreign Key |
| budget | double(0,0) | |
| description | Text | |
| status | int(11) | |

Table 4.11 shows the Donors Table this holds the details of the donor.

Table 4.11 Donors Table

| Column Name | Data Type | Index |
|---|---|---|
| donor_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| donor_name | varchar(255) | |
| phone_number | varchar(255) | |
| location | varchar(255) | |

Table 4.12 shows the Doctors Table that holds the doctors' details.

Table 4.12 Doctors Table

| Column Name | Data Type | Index |
|---|---|---|
| doctor_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| first_name | varchar(255) | |
| last_name | varchar(255) | |
| phone_number | varchar(255) | |
| hospital | varchar(255) | |

Table 4.13 shows the hospitals table these shows the details of the hospital that are available in the application.

Table 4.13 Hospitals Table

| Column Name | Data Type | Index |
|---|---|---|
| hospital_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| hospital_name | varchar(255) | |
| phone_number | varchar(255) | |
| latitude | double(0,0) | |
| longitude | double(0,0) | |

Table 4.14 shows the appointments Table, this captures the appointment requests that have been launched.

Table 4.14 Appointments Table

| Column Name | Data Type | Index |
|---|---|---|
| appointment_id | int(11) | Primary key |
| user_id | int(11) | Foreign key |
| hospital_id | int(11) | Foreign key |
| doctors_id | int(11) | Foreign key |
| request_date | varchar(255) | |
| schedule date | varchar(255) | |
| schedule time | varchar(255) | |

## 4.4 WireFrames

The wireframe gives a visual representation of the system to be developed. The user interface of the web application and mobile application are illustrated. The researcher also elaborates on the functions of the wireframes.

### 4.4.1 Mobile Application WireFrames

The first screen to be launched is the splash screen followed by the login screen as shown in the Appendix D, Figure D.1 and D.2 respectively.

**Registration Screen**

Figure 4.11 shows the registration screen of the mobile application. The details of the patient are captured for further reference.



Figure 4.11 Registration Screen

**Home Page Screen**

Figure 4.12 shows the home page screen of the mobile application. This is where the user gets to once they have successfully registered to the application.
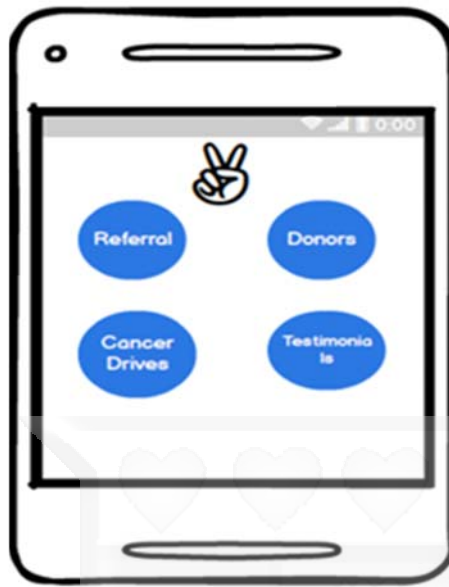


Figure 4.12 Home Page Screen

**Hospital Referral Screen**

Figure 4.13 and Figure 4.14 illustrate the screens that the user navigates, to request an appointment with the hospitals listed in the mobile application.
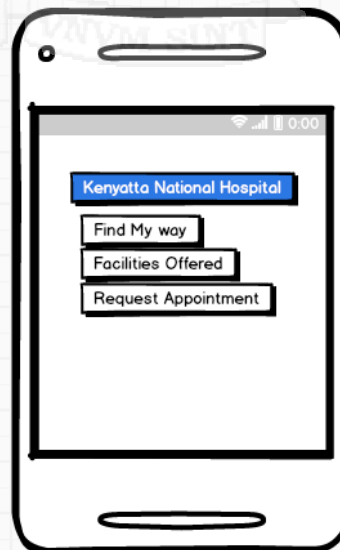


Figure 4.13 Hospital Referral Screen 1          Figure 4.14 Hospital Referral Screen 2

**Doctor Referral Screen**

Figure 4.15 and Figure 4.16 show the doctor referral screens, the user chooses the doctors specialty then views the contacts of the doctor and decides whether to request an appointment or not.



Figure 4.15 Doctor Referral Screen 1        Figure 4.16 Doctor Referral Screen 2

**Donor Screen**

Figure 4.17 shows the mobile applications donor screen and Figure 4.18 shows the message displayed after successfully submitting the request.
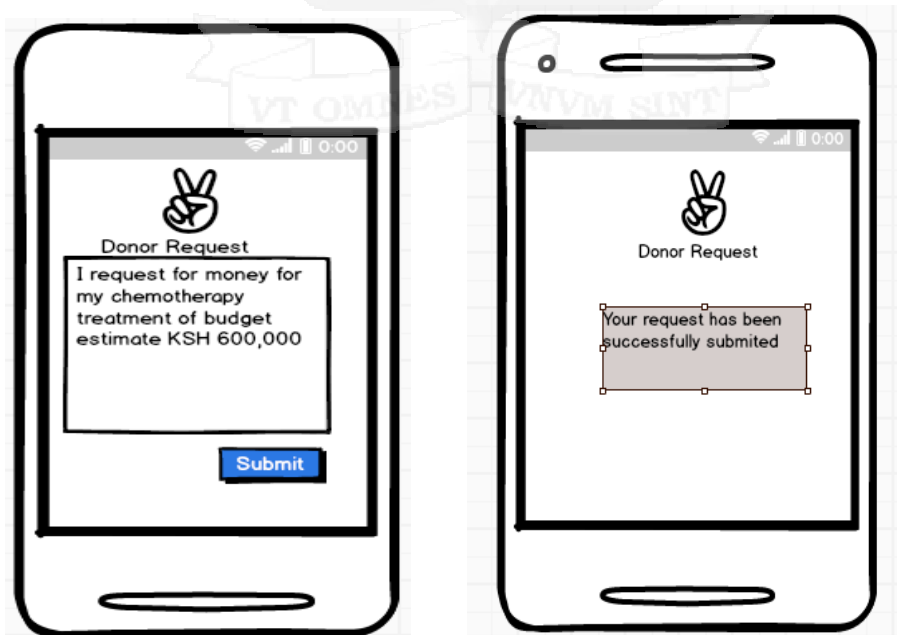


Figure 4.17 Donor Request Screen       Figure 4.18 Donor Request Message display

### 4.4.2 Web Application

The web interface has been designed for the administrator, doctor, hospital representatives and the donors. Figure D.4 and D.5(Appendix E) shows the doctors and hospital representative dashboard respectively.

**Administrator Dashboard**

Figure 4.19 show the web application dashboard for the system administrator. Once the administrator logs in this page appears.
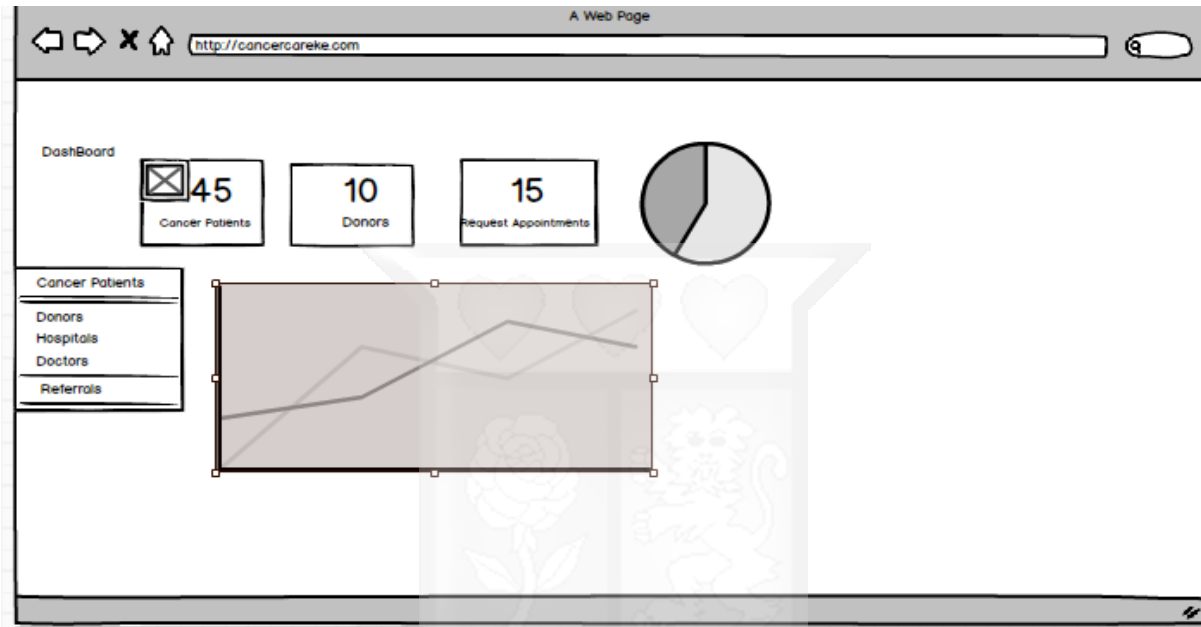


Figure 4.19 Administrator Dashboard

**Patients Details Page**

Figure 4.20 shows the details of the patients registered. It shows their details and requests they have made through the application.
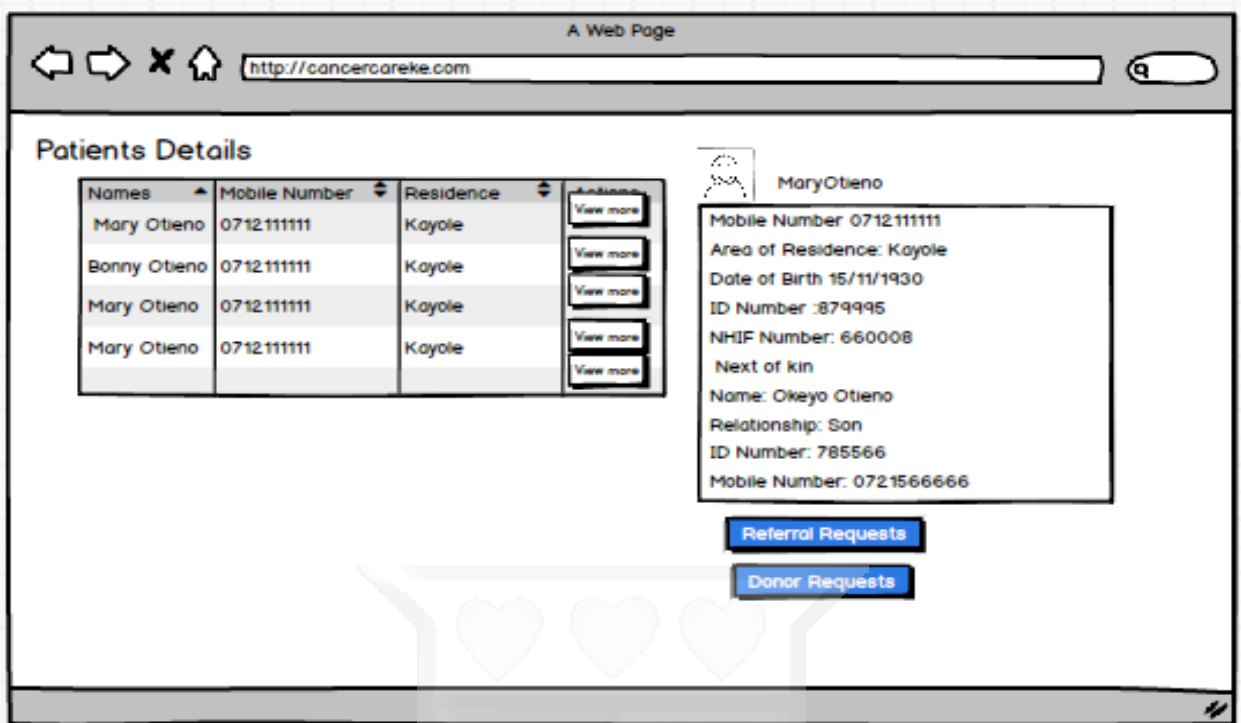
Figure 4.20 Patient Details Page

### 4.5 Conclusion

This chapter has showcased the system design and architecture that the researcher used as a guide for the subsequent chapter. The next chapter discusses how the proposed solution was implemented with the system design in mind.

# CHAPTER FIVE

# SYSTEM IMPLEMENTATION AND TESTING

## 5.1 Introduction

This chapter focuses on the implementation of the proposed solution to assist cancer patients access health care and funding. Screenshots of the working application have been provided to illustrate how the system functions and the interaction the user has on the system.

## 5.2 System Implementation Environment

### 5.2.1 Mobile Application

The mobile application has been developed on the Android platform. The application designed has been optimised for Android version 6.0 and is compatible on Android devices with minimum version 4.0.1. SQL is used as the database query language and JSON used as the web service language for communication between the database and the android front-end.

### 5.2.2 Web Application

The web application has been developed using Laravel 5.4 PHP framework. The application was hosted on an online Server. Laravel PHP framework was used to implement the web application because of its open source nature and multilayer security. MySQL database was used to develop the systems database since it is open source and compatible with PHP programming language.

## 5.3 Functionality of the System

The implemented solution comprises of a Mobile application as well as a Web application. The mobile application is intended for the cancer patients to assist them access health care and funding while the Web application is intended for the system administrators as well as the donors and health care practitioners.

### 5.3.1 Mobile Application

**Login and Registration**

The system implementation required that users login to the mobile application with their emails and passwords in order for them to access the application. Users also register their personal details that will be needed to process their request for funds.

**Referrals**

The researcher implemented the mobile application to connect the patients to either a hospital facility or an oncologist. The patients can request an appointment to a hospital to use a facility they need for cancer treatment. They could also request a doctor's appointment. Once their appointment has been confirmed they are notified through the application.

**Donor Request**

The mobile application allows the patient to request for funding. The request indicates the amount needed for cancer treatment. This is to enable the donors to raise the amount stated and pay to the patients NHIF account as well as paying the deficit amount indicated to whom it is payable.

**Cancer Drives**

This section lists the cancer events that stakeholders, assisting in the cancer situation in Kenya might have. Events such as cancer fundraising, cancer-free screening and awareness are listed in this section.

**Testimonials**

Cancer patients can view testimonials of other cancer patients who have undergone treatment and are either improving on their health or have totally been declared cancer free. This is to give them hope and encouragement as they battle with cancer.

### *5.3.2 Web Application*

The web application comprises of the administrator module, doctors' module, health official module as well as donor module. The administrator module has been implemented to manage the users and oversee the other modules while the other web modules have been designed to manage the various user requests.

### 5.4 Implementation Details

**Mobile Application**

The application has the following system modules.

**Home Screen**

Figure 5.1 shows the saved profile of the patient while Figure 5.2 shows the different menus that the patient can choose to access the services offered by the application.
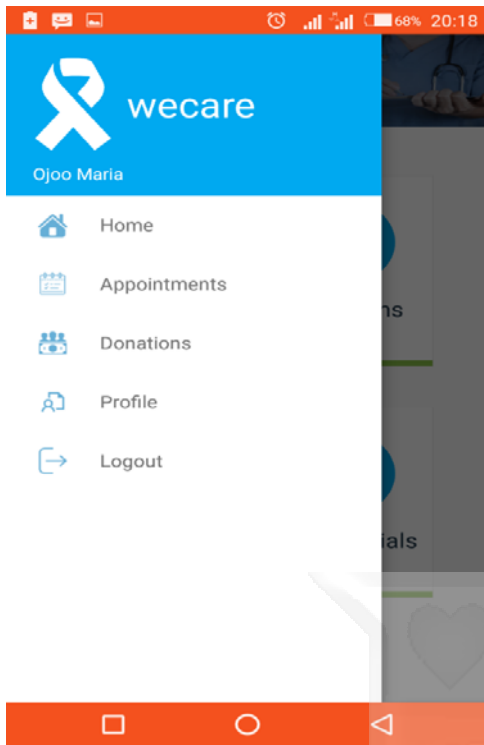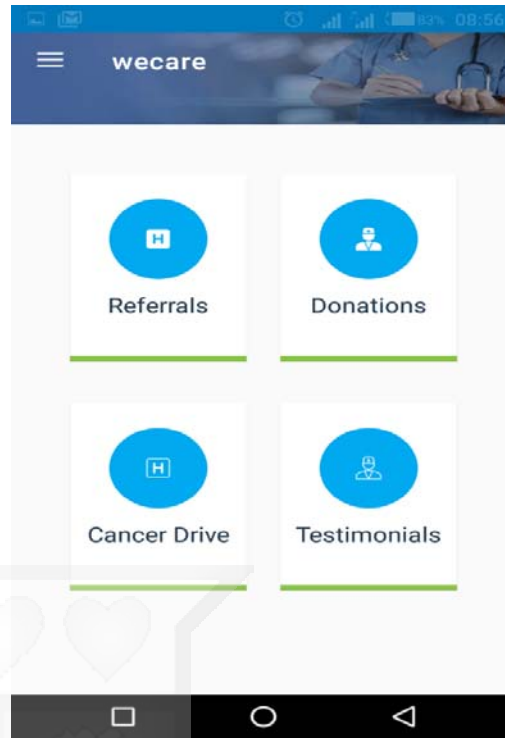
Figure 5.1 Patients Profile          Figure 5.2 Application Menu

**Patient Profile Registration**

Figure 5.3, Figure 5.4 and Figure 5.5 shows the patient profile registration. The users give their personal details, their next of kin details as well as their medical history. The information taken here is confidential and only taken for the purpose of requesting funds from donors.
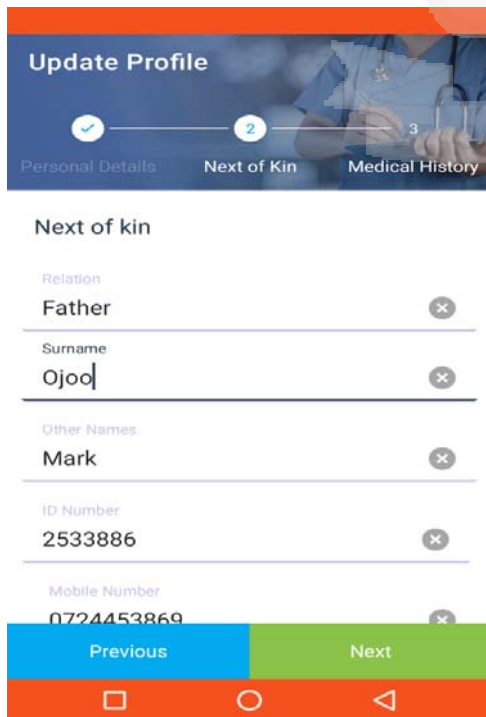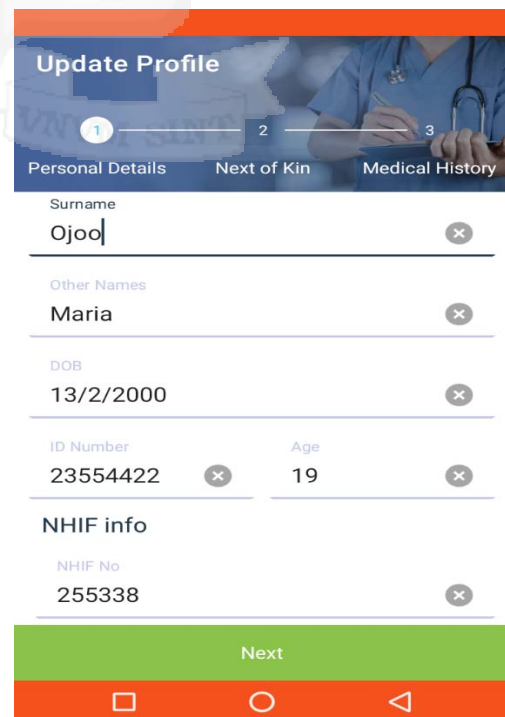


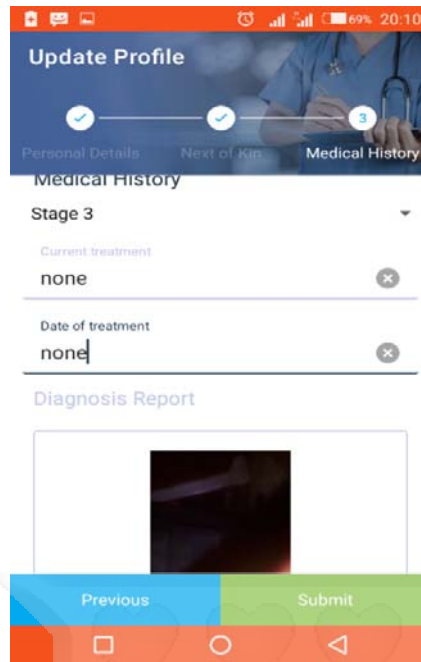Figure 5.3 Next of Kin          Figure 5.4 Personal Details

Figure 5.5 Medical History

**Medical Treatment Referral**

Figure 5.6, Figure 5.7 and Figure 5.8 show the sequence that a user takes to request for an appointment for medical treatment. Once they choose a health facility, they can view their location and request an appointment.
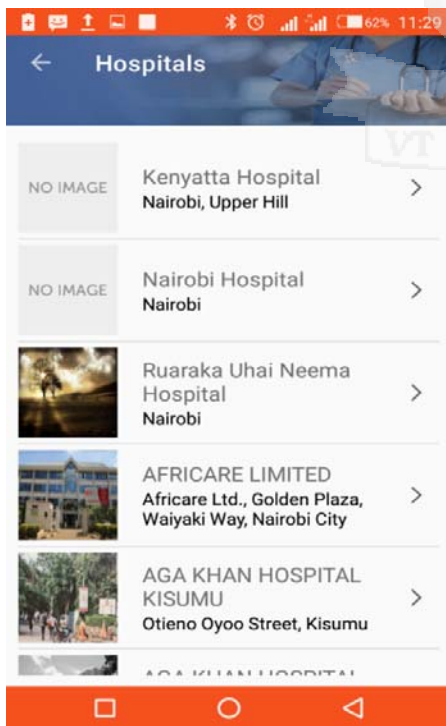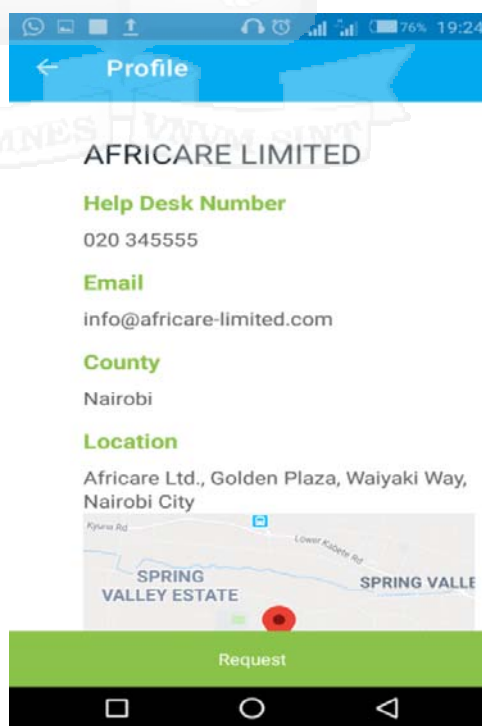


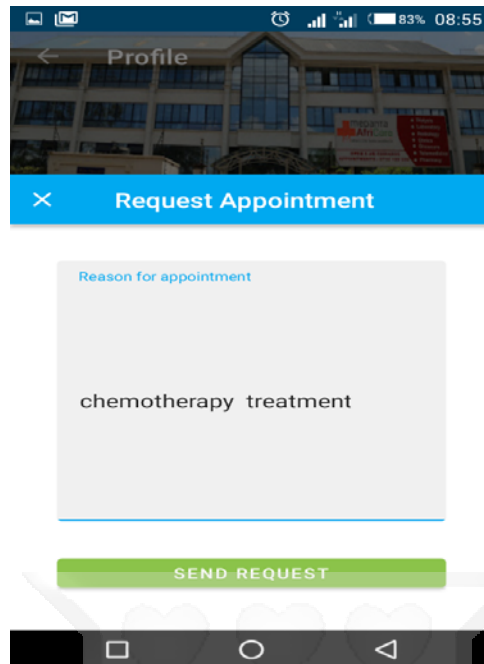Figure 5.6 List of Hospitals                     Figure 5.7 Hospital Details

Figure 5.8 Appointment Request

Figure 5.9 and Figure 5.10 show the successful response that the patient receives once they have requested an appointment from a hospital facility.
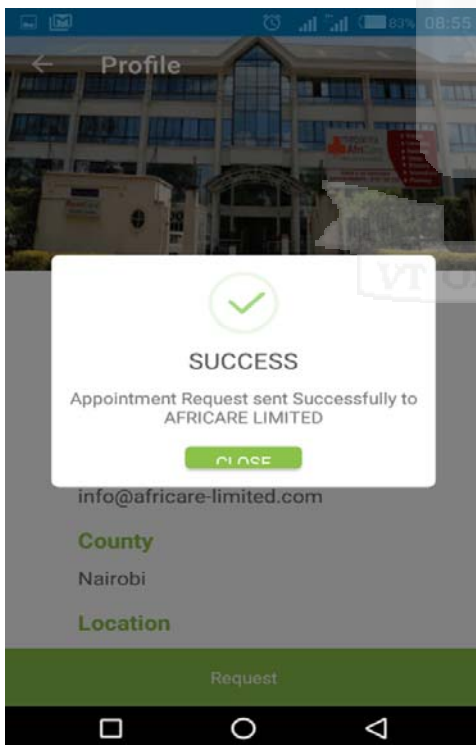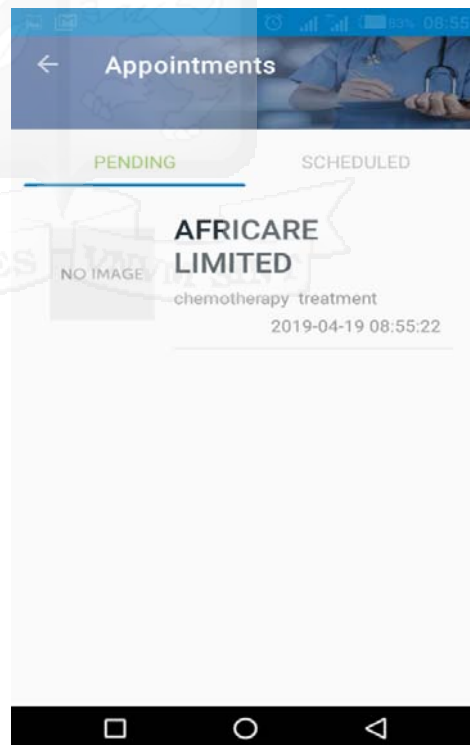


Figure 5.9 Success Response Message      Figure 5.10 Appointment Profile

**Web Module**

The web back-end has a login screen for the various system users that is the doctors, hospital representatives and donors as shown in Figure E.5 (Appendix F). Once they login they are able to access their different modules.

**Administrator's Dashboard**

Figure 5.11 shows the administrators dashboard. The administrator can view the different functionalities of the system as well as different statistics.
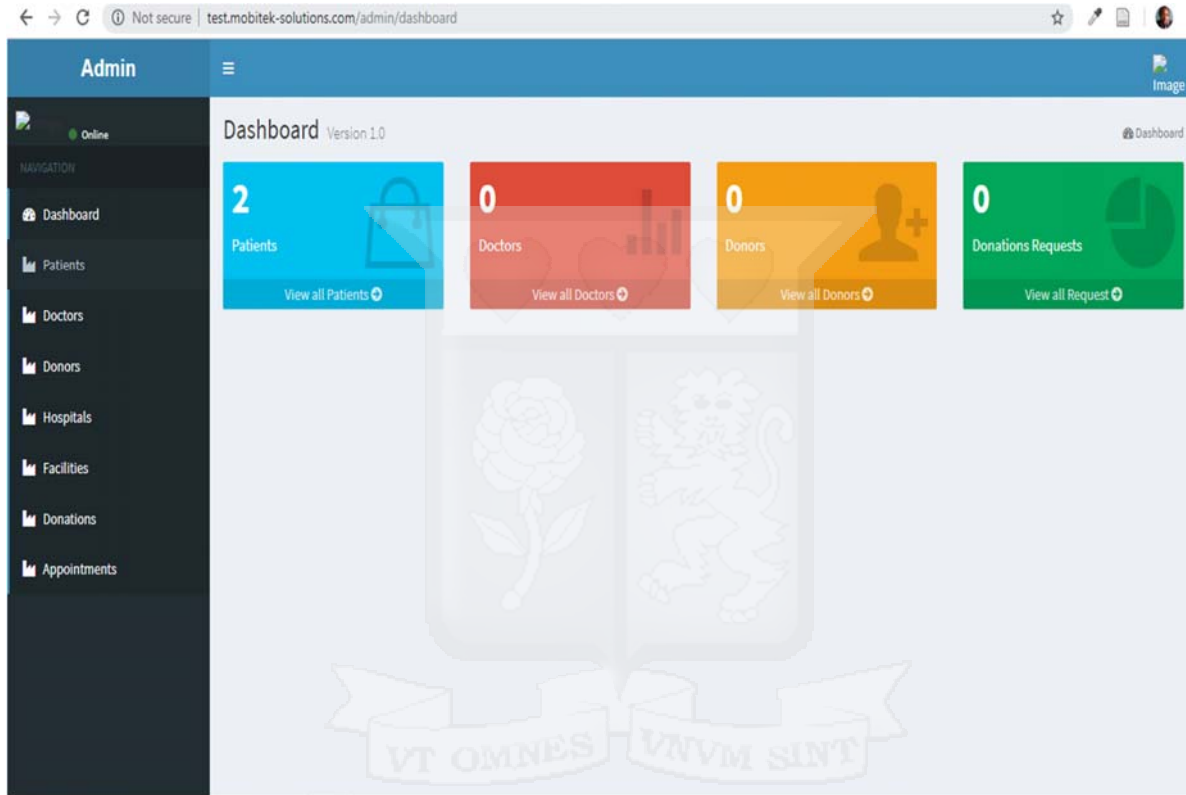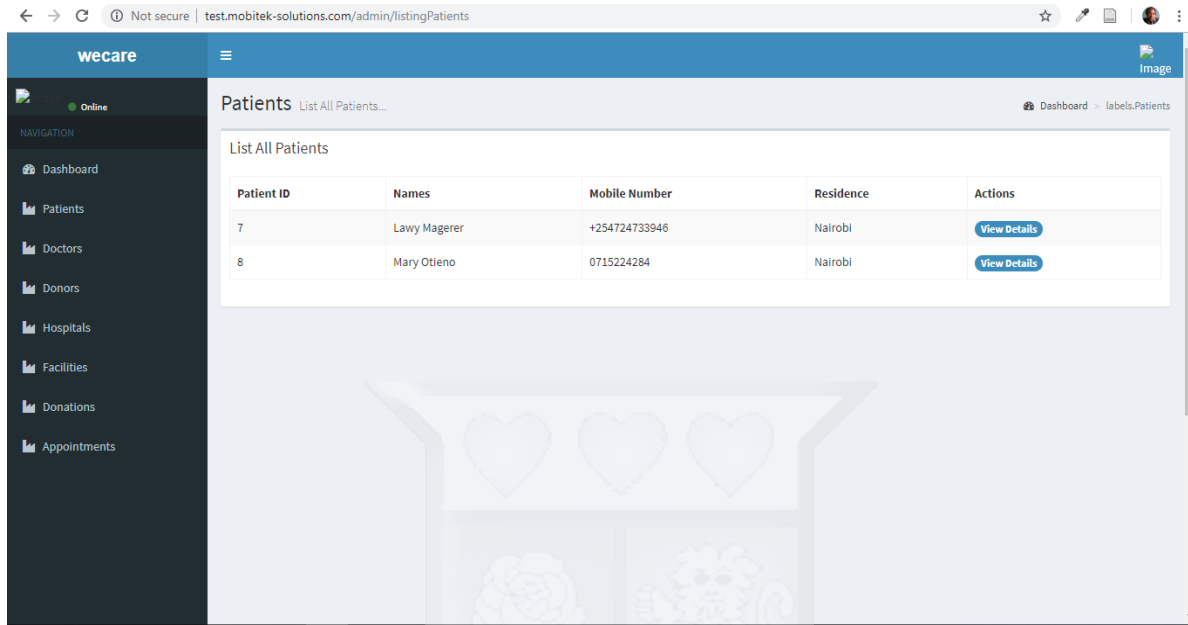


Figure 5.11 Administrator Dashboard

**Patient List**

Figure 5.12 show the list of patients who have registered themselves to the application. The administrator can view their profile and perform more actions on them.



Figure 5.12 Patient List

**Full Patient Details**

Figure 5.13 shows the details of the patient. The administrator views the referral requests that have been made by the patient and send the patients details to the donor for funding purposes.
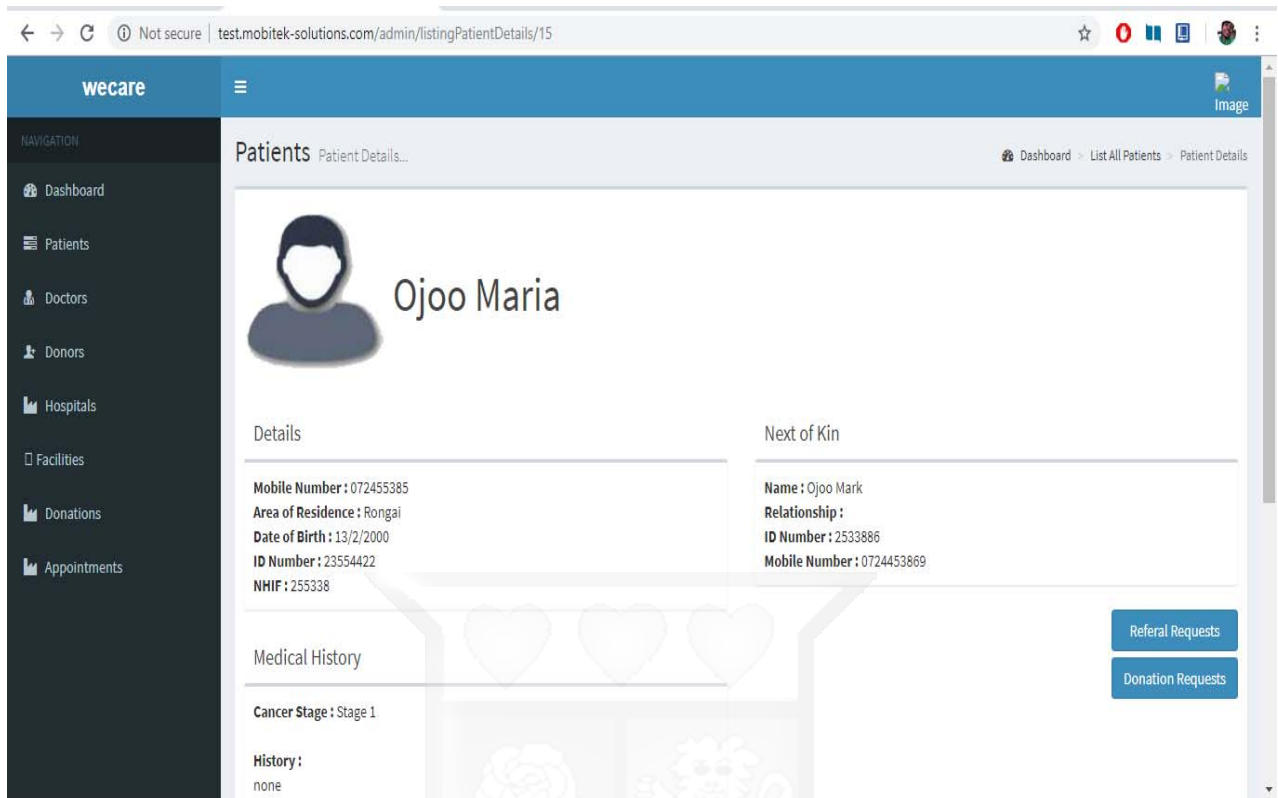
Figure 5.13 Patient List

## 5.5 System Testing

### 5.5.1 Functional Testing

Functional testing was done to ascertain that the application meets the requirements that it was intended to perform. The following tests were carried out.

Table 5.1 User Registration and Login Table

| Test Case Name: User Registration and Login | Test Case: 1 | | |
|---|---|---|---|
| Brief Description: Users create their account using their emails and generate a password which they use to login to the system | | | |
| Pre-condition: The user must have installed the application and have access to the internet. | | | |
| Step | Action | Expected results | Pass/Fail |
| 1. | User runs the application | The application launches the splash screen then loads the login page | Pass |

| 2. | User clicks on the sign-up link to create an account in the system. | The registration screen opens | Pass |
| 3 | The user fills all registration details and clicks on Create Account button | The applications returns a successfully registered account message and loads the login page | Pass |
| Post condition: User can login to the system and access the systems functionalities | | | |

Table 5.2 Adding Personal Information Table

| Test Case Name: Adding Personal Information | Test Case: 2 | | |
|---|---|---|---|
| Brief Description: Users are to add their personal details to create their profile on the system | | | |
| Pre-condition: The user must have installed the application and have access to the internet. | | | |
| Step | Action | Expected results | Pass/Fail |
| 1. | User runs the application | The application launches the dashboard screen | Pass |
| 2. | User clicks profile | The profile registration page appears | Pass |
| 3 | The user fills all information and clicks on the save button | The applications returns a successfully profile created | Pass |
| Post condition: User can view the profiles they have created | | | |

Table 5.3 Request for Funding Table

| Test Case Name: Request for Funding | Test Case: 3 | | |
|---|---|---|---|
| Brief Description: Users request for funding for their treatment | | | |
| Pre-condition: The user must have installed the application and have access to the internet. | | | |
| Step | Action | Expected results | Pass/Fail |

| | | | |
|---|---|---|---|
| 1. | User runs the application | The application launches the splash screen then loads the login page | Pass |
| 2. | User clicks on the link to request for funds | The donor request opens | Pass |
| 3 | The user fills all the budget details for the treatment | The applications returns a successfully submitted request | Pass |
| Post condition: User can login to the system and access the systems functionalities | | | |

Table 5.4 Request Doctor's Appointment

| Test Case Name: Request for Doctor Appointment | | Test Case: 4 | |
|---|---|---|---|
| Brief Description: Users request for doctor's appointment | | | |
| Pre-condition: The user must have installed the application and have access to the internet. | | | |
| **Step** | **Action** | **Expected results** | **Pass/Fail** |
| 1. | User runs the application | The application launches the splash screen then loads the login page | Pass |
| 2. | User clicks on the tab to request for doctor's appointment | The doctor referral page opens up | Pass |
| 3 | The user chooses the specialty of the doctor | The applications returns the list of specialties available | Pass |
| 4 | The user chooses the doctor in the specialty chosen and requests for appointment to be scheduled | The application returns a successfully submitted request | Pass |
| Post condition: User can login to the system and access the systems functionalities | | | |

Table 5.5 Request Hospital Facility Appointment

| Test Case Name: Request for Hospital Facility Appointment | | Test Case: 5 | |
|---|---|---|---|
| Brief Description: Users request for Hospital facility appointment | | | |
| Pre-condition: The user must have installed the application and have access to the internet. | | | |
| Step | Action | Expected results | Pass/Fail |
| 1. | User runs the application | The application launches the splash screen then loads the login page | Pass |
| 2. | User clicks on the tab to request for Hospital Appointment | The hospital referral page opens up | Pass |
| 3 | The user chooses the facility needed | The applications returns the list of facilities and hospitals with the facility needed | Pass |
| 4 | The user chooses the hospital and requests for an appointment | The application returns a successfully submitted request | Pass |
| Post condition: User can login to the system and access the systems functionalities | | | |

### 5.5.2 User Testing

The user testing was done by the end users of the application. The testing was done to achieve the following: the ease of use, user friendliness, user acceptance and functionality.

**User Acceptance**

End users were asked whether they would use the application to request for funding and access to health care as per the questionnaire attached in Appendix B. All the respondents affirmed that they use the application as seen in Figure 5.14.
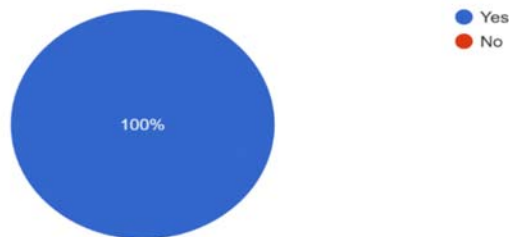


Figure 5.14 User Acceptance

**User Friendliness**

The respondents were asked on the ease of use, navigation across the application.85 % of the respondents affirmed that is was easy to use the mobile application while 15 % of them rated it as average as shown in Figure 5.15.
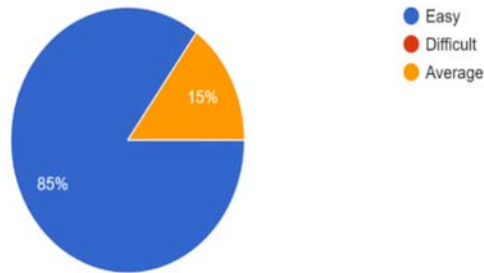


Figure 5.15 User Friendliness

**Functionality**

End users were asked if the application developed met their needs of accessing health care and funding. All the respondents affirmed that the application met their needs as seen in Figure 5.16.
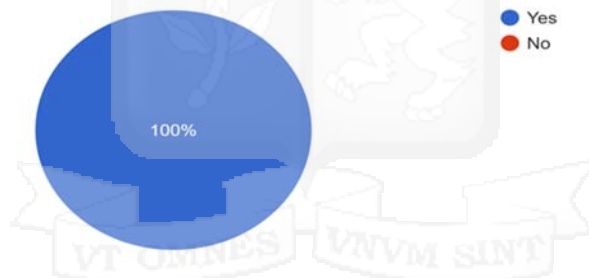


Figure 5.16 Functionality Testing

### 5.5.3 Compatibility Testing

The web application was tested on different browsers. The Table shows the same results obtained on the browsers listed.

Table 5.6 Web Browser Compatibility

| Web Browser | Compatibility |
|---|---|
| Internet Explorer – Version 4 and above | Yes |
| Mozilla Firefox – Version 4 and above | Yes |
| Chrome – all versions | Yes |

The mobile application was tested on the following Android platforms and found to be compatible as shown in the Table 5.7.

Table 5.7 Android Platform Compatibility

| Android Platform | Compatible |
|---|---|
| Android 10 – 2.3.3 | Yes |
| Android 11 – 3.0 | Yes |
| Android 12 – 3.1 | Yes |
| Android 13 – 3.2 | Yes |
| Android 14 – 3.0 | Yes |
| Android 15 – 4.0 | Yes |
| Android 16 – 4.0.3 | Yes |
| Android 17 – 4.1 | Yes |
| Android 18 – 4.2 | Yes |
| Android 19 – 4.3 | Yes |
| Android 20 – 4.4 | Yes |
| Android 21 – 4.4W | Yes |
| Android 22 – 5.0 | Yes |
| Android 23 – 5.1 | Yes |
| Android 24 – 6.0 | Yes |

## 5.6 System Evaluation and Testing

Validation testing was done to validate whether the mobile application would assist patients to access health care and funding. A questionnaire was designed as seen in Appendix C and given to the end users to respond alongside the mobile application.

All respondents who participated in the usability testing also participated in the validation testing as shown in Figure 5.17. Figure 5.17 shows the respondents details on whether they tested the mobile application. They all affirmed that they participated.
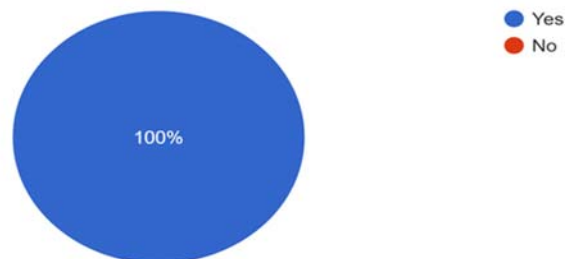


Figure 5.17 Respondents' participation in usability testing

The respondents were asked to indicate whether the functionalities provided by the mobile application assists in accessing health care and funding. 20% of the respondents indicated that it did not fully meet the functionalities while 80% of the respondents indicated that it met the functionalities needed as shown in Figure 5.18.
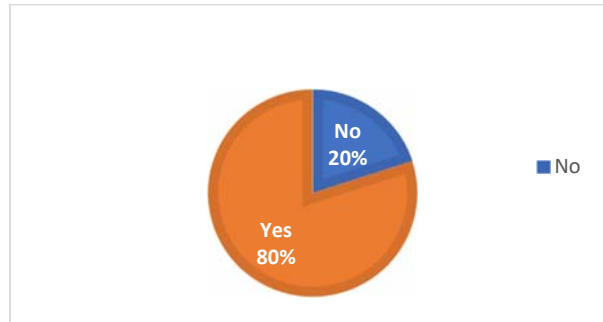


Figure 5.18 Respondents on whether the mobile application met the functionalities

The respondents were also asked to indicate whether they were satisfied with the solution provided by the mobile application in assisting to access health care and funding. 30% of the respondents indicated they were not fully satisfied while 70% indicated that they were satisfied in the solution provided as indicated in Figure 5.19.
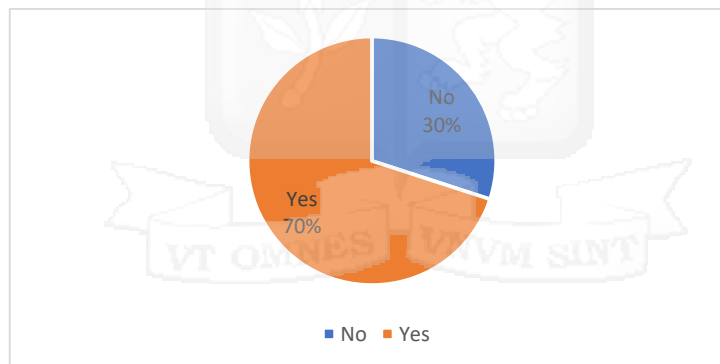


Figure 5.19 Respondents on their satisfaction with the mobile application

The respondents were asked whether they would recommend the mobile application, to be used to assist in accessing health care and funding. They all affirmed that they would recommend the mobile application as indicated in Figure 5.20.
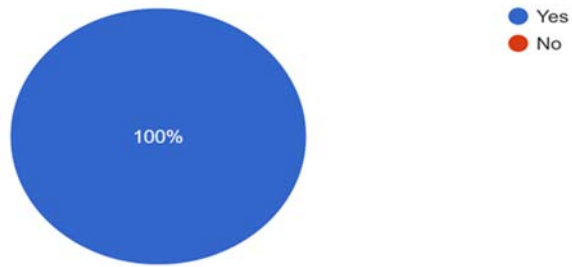
Figure 5.20 Respondents on whether they would recommend the mobile application

**5.7 Summary**

The chapter has explained how the system was implemented and the various tests done to the mobile application and web application that was developed. Questionnaires were used as shown in Appendix B and Appendix C to ascertain the tests done.

# CHAPTER SIX

# DISCUSSION

### 6.1 Introduction

The purpose of the research was to assist cancer patients to access health care and funding in Kenya. The fight against cancer has been on the increase, with increased efforts by various stakeholders in both the government and private sectors. The findings from the research aided in identifying the challenges that cancer patients face when accessing health care and the need for funding their medical treatment. This chapter elaborates the finding and achievements of the research study as well as the review of the research objectives.

### 6.2 Findings and Achievements

Cancer has been identified as the second leading cause of death worldwide according to a research done (Nagai & Kim, 2017)). In Kenya, which was the main focus of this research study, cancer has been found to be the third leading cause of death after infectious and cardiovascular diseases. The research has reviewed the challenges that cancer patients face when accessing health care and funding. Cancer treatment has three modalities depending on the advice from the oncologist namely chemotherapy, radiology and surgical operation. For instance, it costs between Sh172,000 and Sh759,000 to treat cervical cancer without surgery here in Kenya and Sh672,000 to Sh1.25 million if one goes through an operation, according to scholars affiliated to the National Cancer Control Programme and the National Cancer Institute, Kenya.

Accessing affordable health care has been a challenge for self-sponsored patients with no medical insurance cover. Majority of Kenyans rely on public health facilities for medical treatment though the public health facilities with full cancer treatment are few. It has been noted that Kenyatta is the only public hospital which provides the full cancer treatment.

National Health Insurance Fund cover an initiative by the Kenyan government, included a cover to reduce the cancer cost burden among the patients and their families. The minimum amount one is to pay to be insured is Ksh. 500 monthly. According to the Chief Executive Officer of NHIF, the insurance cover for chemotherapy is capped at Ksh. 600,000 per beneficiary which covers six cycles that is administered monthly. The NHIF cover is also acceptable in registered private hospitals thus reducing the congestions in accessing the same services in public hospitals.

The mobile application registers cancer patients and assists them to access health care and funding. The patients is able to request for funds through the application as their NHIF cover number is captured and the deficient amount after NHIF payment is also noted and details sent to the administrator for verification of details and forwarding to donors for payment. Cancer patients are

also able to view hospital facilities that offer various cancer services that they might want and request for appointment, they are also able to view the listed doctors and request an appointment with them.

### 6.3 Review of Research Objectives

The research identified the challenges that cancer patients face when accessing health care and funding. A mobile and web application has been designed based on the requirements gathered and research done. Majority of the respondents indicated that they get funds for their medical treatment from well wishes and family members as shown in Figure 4.3. This is because cancer treatment is expensive and thus getting funds from people is inevitable considering that no one plans for the disease to strike.

The second objective was to review the initiatives that are currently being used to assist cancer patients in accessing health care and funding. The research study, reviewed literature that indicated several initiatives by the Kenyan government and several non-governmental organisations to assist in the cancer burden in Kenya. The NHIF cover introduced by the government now covers cancer treatment but with a limited subscription though the Ministry of Health has plans underway to fully cover the cancer treatment and not only the treatment cycles.

The third objective was to review technologies and applications that exist to assist patients in accessing health care and funding. The research study found a couple of applications that were used to assist in accessing medical consultation as well as applications that assist to save funds for medical expenses. The technology used included SMS, USSD, smart card and smart phone based applications.

The fourth objective was to design, develop and test the mobile application to assist cancer patients to access health care and funding. The funding was attained through the design, development and testing of the web and mobile application. The mobile application was developed for the Android platform and the web application was developed with the Laravel framework. Test done on the system included functional testing, compatibility testing to the web application on the various web browser versions and the Android application was tested on the various Android versions.

The fifth objective was to validate the mobile application. A few of the potential users of the mobile application were given the mobile application to test its validity as they respond to the questionnaire in Appendix B attached. The potential users affirmed that the mobile application would assist them in accessing health care and funding.

# CHAPTER 7

## CONCLUSIONS, RECOMMENDATIONS AND FUTURE WORK

### 7.1 Introduction

The researcher has developed a mobile application running on the Android platform to assist cancer patients to access health care and funding. This chapter elaborates the conclusions, recommendations and future works in the research study.

### 7.2 Conclusions

The main purpose of this dissertation was to design and develop a mobile application that would assist cancer patients to access health care and funding. This purpose has been met by the researcher and validated by potential users, the other objectives have also been discussed and achieved. Cancer has been identified to be a national burden as seen in the mortality rate as noted in the research study. There are increasing efforts by both the government and non-governmental organisations to reduce the number of deaths associated with cancer. The mobile application assists cancer patients to identify the nearest cancer centre that they can get treatment as well as enabling them to contact an oncologist to book an appointment. It also assists them to seek for funds from donors as it captures their NHIF details and the deficit amount that would be needed for the full treatment which will be directly paid to the hospital facility.

### 7.3 Recommendations

The research shows one of the reasons that has led to the increased rate of cancer deaths is due to lack of access to health care and fund. Early screening of the disease is also of the essence in treatment as it increases the survival rate of the patients. Awareness, sensitisation and screening of cancer should be made easily available and emphasized on to all citizens so that patients do not get treated when the disease has spread all over or at a stage that nothing much can be done to cure the patient.

### 7.4 Future Works

The proposed application developed can be extended in the future. Firstly, the application can be developed on other mobile platforms such as iPhone and Windows to reach out to other users who have no access to Android phones. Secondly, more research should be done on how the solution can assist to in cancer awareness and screening.

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# Appendix A: System Requirements

Dear Respondent,

I am a Master's student in the Faculty of Information Technology, Strathmore University conducting a research entitled, a Mobile application to Assist Cancer Patients Access Health Care and Funding in Kenya.

You have been selected to form part of this research study. I kindly request you to complete the questionnaire. The information requested is needed for academic purposes only and will be treated in strict confidentiality.

Kind Regards,

Mercy Serem

1. Do you have a smart phone?
   - o  Yes
   - o  No

2. If Yes, which operating system is the phone running on?
   - o  Android
   - o  IOS
   - o  Blackberry
   - o  Other
   - o  No idea

3. How do you finance your hospital bills?
   - o  Savings
   - o  Health Insurance
   - o  Family members/well wishers
   - o

4. What challenges have you faced when accessing health care
   - o  Long queues
   - o  Lack of funds
   - o  Distant location of Health care Facility
   - o  Poor health service delivery

   **Thank you for your time, I highly appreciate.**

# Appendix B: User Testing Questionnaire

Dear Respondent,

I am a Master's student in the Faculty of Information Technology, Strathmore University conducting a research entitled, a Mobile application to Assist Cancer Patients Access Health Care and Funding in Kenya.

You have been selected to form part of this research study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidentiality.

Kind Regards,

Mercy Serem

1. How do you find the user interface of the mobile application on the basis of its look and feel? (Choose ONE)

- o Attractive
- o Average
- o Not Attractive

2. Rate the mobile application on the basis of whether the application was easy to learn especially for a first-time user? (Choose ONE)

- o Easy
- o Average
- o Difficult

3. Does the system functionality meet the user requirements? (Choose ONE)
- o Yes
- o No

4. Would you use the mobile application to access healthcare and funding? (Choose ONE)
- o Yes
- o Not Sure
- o No

**Thank you for your time, I highly appreciate**

# Appendix C: Validation Questionnaire

1. Did you take part in the user testing of the mobile application?
     o   Yes
     o   No
2. Does the functionalities provided by the mobile application assists in accessing health care and funding?

   o   Yes
   o   No

3. Are you satisfied with the solutions provided by the mobile application as far as assisting to access health care and funding is concerned?

   o   Yes
   o   No

4. Would you recommend the mobile application to be adopted in assisting to access health care and funding?

   o   Yes
   o   No

# Appendix D: Database Schema

Table C.1: Users Table

| Column Name | Data Type | Index |
|---|---|---|
| Id | int(11) | Primary key |
| Email | varchar(255) | |
| Password | varchar(255) | |
| user_type | varchar(255) | |

Table C.2: Donation Table

| Column Name | Data Type | Index |
|---|---|---|
| donation_id | int(11) | Primary key |
| request_id | int(11) | Primary key |
| Amount | double(0,0) | |
| date_approved | timestamp(0,0) | |

Table C.3: Facilities Table

| Column Name | Data Type | Index |
|---|---|---|
| facilities id | int(11) | Primary key |
| facilities_name | varchar(255) | |
| description | varchar(255) | |

Table C.4: Specialities Table

| Column Name | Data Type | Index |
|---|---|---|
| specialties_id | int(11) | Primary key |
| user_id | int(11) | Foreign Key |
| description | varchar(255) | |

# Appendix E: Wire frames



Figure D.1: Splash screen

Figure D.2: Login screen
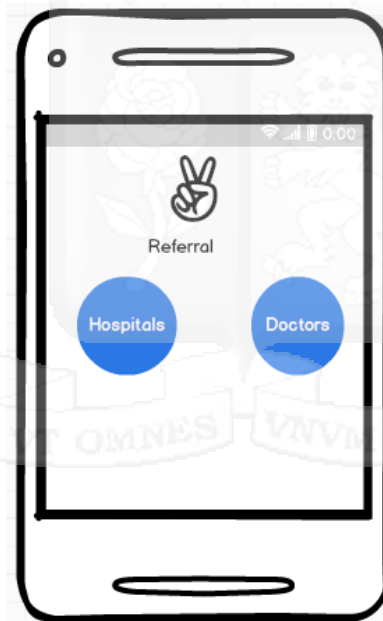


Figure D.3: Referral Screen
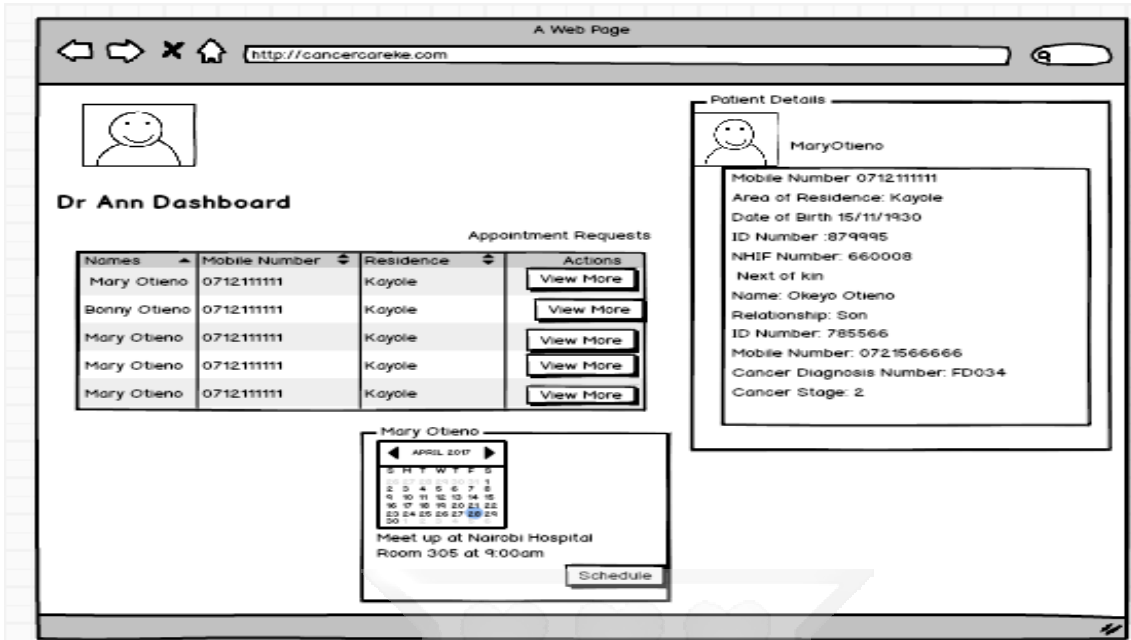
Figure D.4: Doctors Page

Figure D.5 illustrates the Hospitals dashboard the details of the patients who have requested an appointment to use a hospital facility.
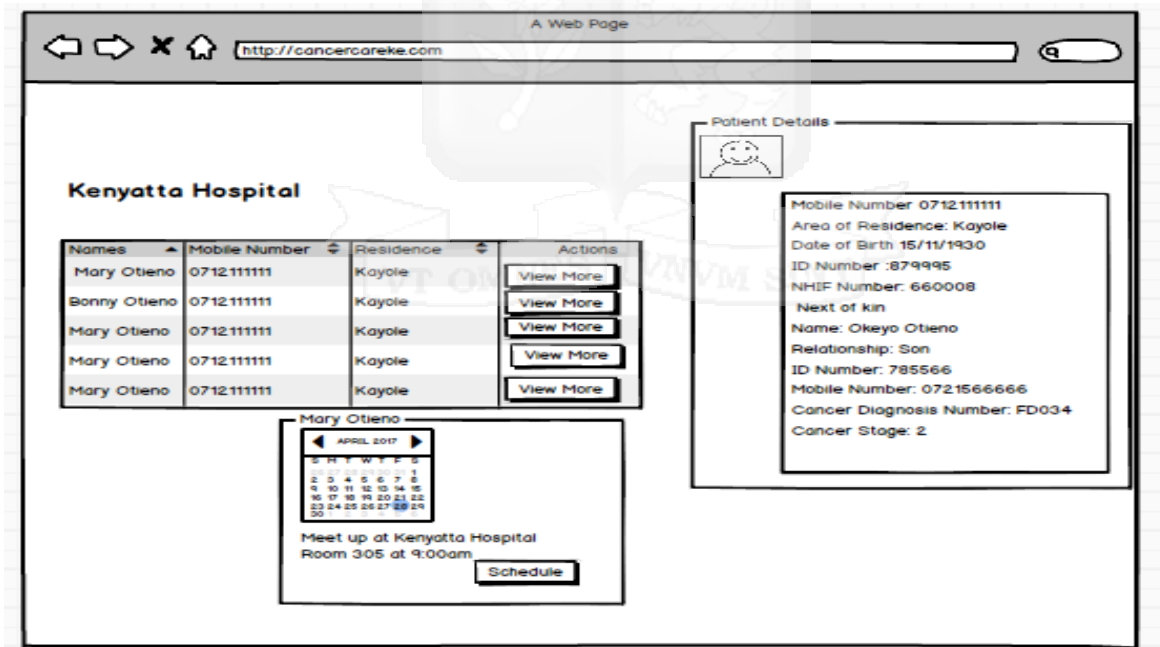


Figure D.5: Hospital Page

# Appendix F: Application Screenshot



Figure E.1: Splash Screen
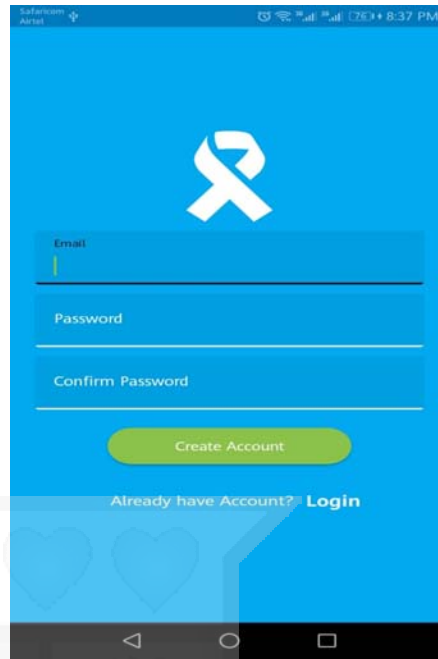


Figure E.2: Registration Screen
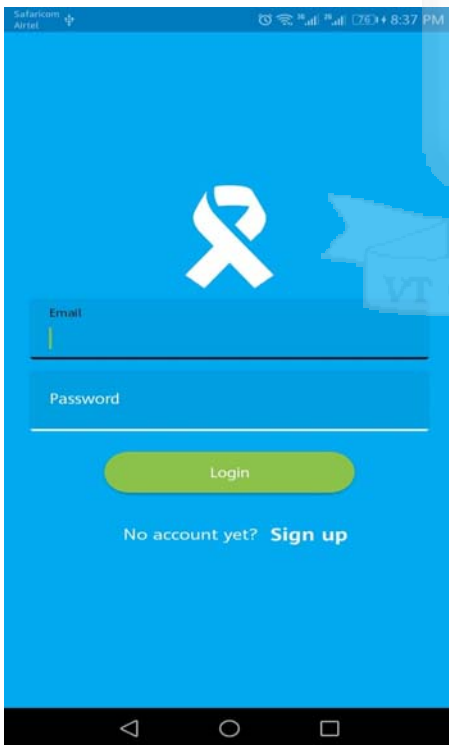


Figure E.3: Login Screen
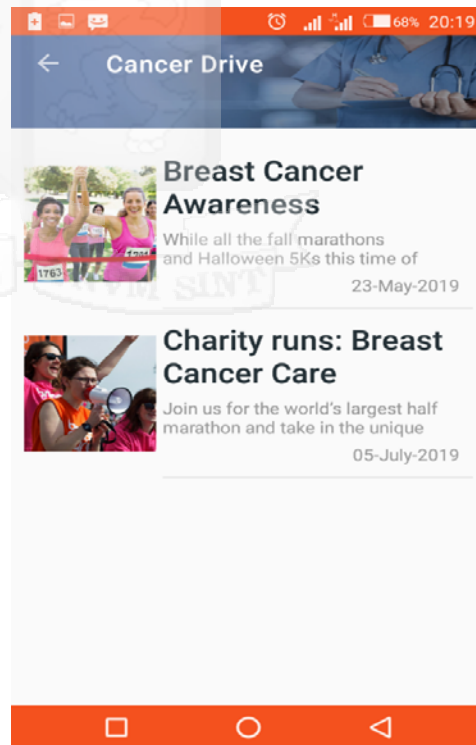


Figure E.4: Cancer Drive Screen
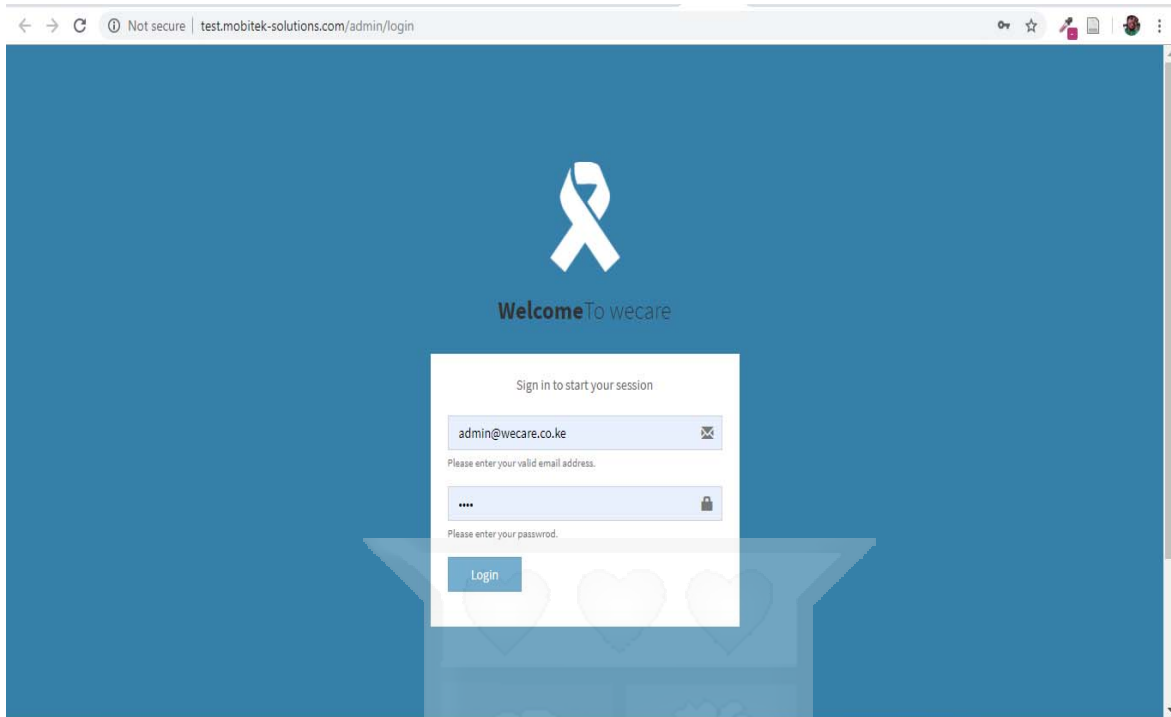
Figure E.5: Web Application Login page
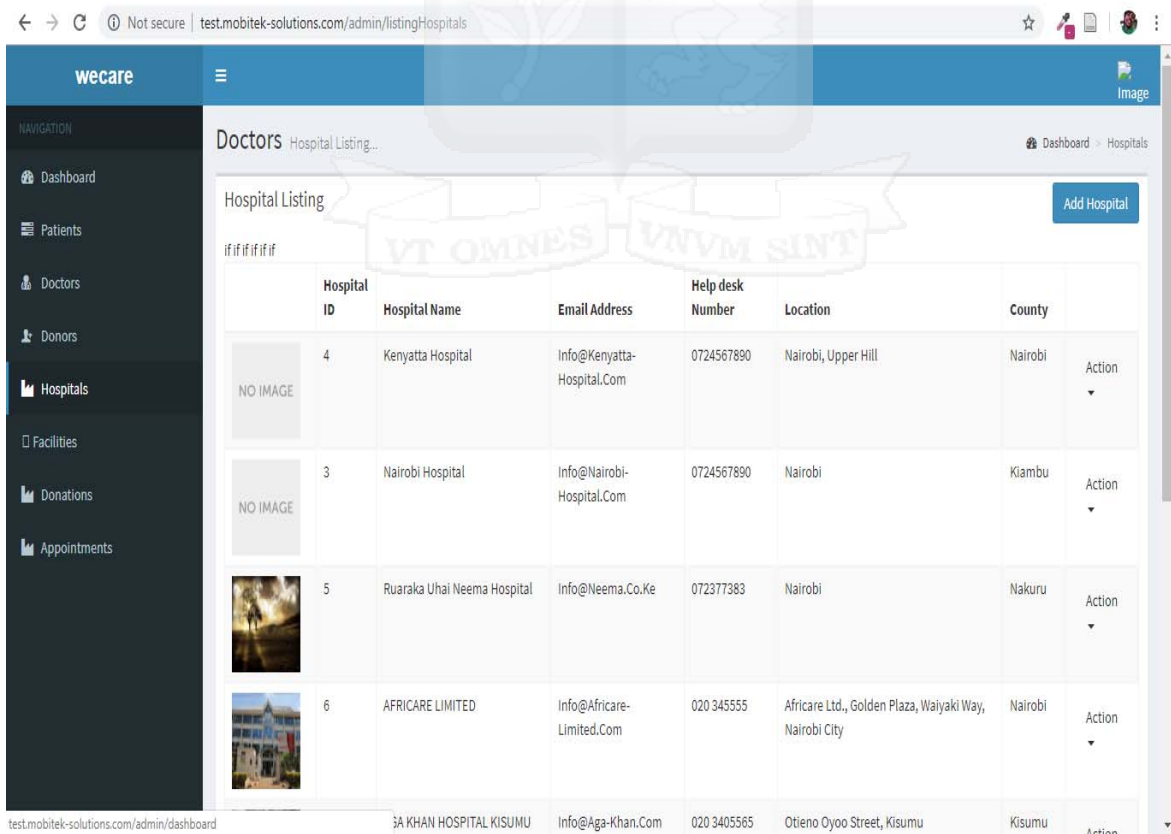


Figure E.6:  Hospital Listing

Figure E.7: Doctors Listing



Figure E.8: Appointment Requests

Figure E.9: Doctors Dashboard

# Appendix G: Turnitin Report