DEDAN KIMATHI UNIVERSITY OF TECHNOLOGY FINAL YEAR PROJECT PROPOSAL.

BACHELOR OF SCIENCE IN INFORMATION TECHNOLOGY

MOBILE-BASED DEKUT MEDICAL CENTRE TELECONSULTATION SYSTEM

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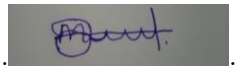
A Project proposal submitted to the department of Information Technology in the School of Computer Science and Information Technology in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Information Technology at Dedan Kimathi University of Technology.

FEBRUARY, 2021

DECLARATION

I declare that this is my original work and has not been presented in any University for a degree or for any consideration of any certification.

Student: ROBINSON MURIKI GITHAE Sign…  ……Date: 15/02/2021

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This proposal document has been submitted with my approval as the university supervisor.

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Department of Information Technology.

ACKNOWLEGMENT

I take this opportunity to first thank the Almighty God for the gift of life and good health throughout the preparation of this proposal. I am also grateful to my supervisor Mr. Patrick Ndungu for his endless guidance on what was expected of me throughout this proposal. He has continuously showed commitment by responding to all questions and offered advice on the way forward, which was key in the proposal preparation.

ABSTRACT

Teleconsultation enables remote consultation between the doctor and the patient located in different geographical locations using either asynchronous or synchronous modalities of communication. Some of these modalities include the use of telephone calls, text messages, chat, video calls and emails to virtually connect the patient to the medical expert. The purpose of this study is to create a computerized teleconsultation system to enable students who seek treatment at the Medical Centre located in Dedan Kimathi University do so conveniently. Sick students residing far away from the university are met with the problem of having to physically travel to the Medical Centre of the institution when seeking treatment. Students are also met with a relatively high cost of fare, a tedious journey as well as time wastage at the bus station or bus stop. The main objective of this study is to develop a mobile based teleconsultation system that will make the process of seeking treatment as effortless as possible for the sick student residing far away from the University. The proposed system will provide an interface through an android application for both the student and the clinical officer located at the universities clinic to communicate remotely. Sick students will be able to login into the application, send their symptoms via the chat functionality to the clinical officer, have a video call with the clinical officer, receive prescription online accompanied by the medicine cost information messages as well as get a visualization of the progress of taking the medicine at the comfort of their hostels. This study will mainly collect primary data. Field research methods will be used to collect data from Dedan Kimathi University students who seek treatment from the Medical Centre. A descriptive survey will be utilized for this study. The survey will use an online questionnaire, disseminated through Google Forms, as its research instrument. Convenience sampling, a non-probability sampling technique, will be used to select the study participants, who will be students at the university. Only students available at the time of data collection will be involved in the study. Data analysis will be done using software tools such as Google forms and MS Excel. Case studies will be used in the literature review to develop a deep analysis of previous teleconsultation systems that have been done. The strengths and weaknesses of each of the case will also be drawn. Rapid Application Development(RAD), a user-centered software methodology that emphasizes on prototyping will on the other hand be employed in the development of the teleconsultation software system.

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CHAPTER ONE: INTRODUCTION

1.1 Background to the Study

Teleconsultation is a mode of service delivery that seeks to enable synchronous or asynchronous Communication for parties at different locations. Synchronous consultations usually involve real time consultations where both parties are connected online such as through real-time video while in asynchronous, both parties need not to be available at the same time. Examples of some of the asynchronous modes utilized include: emails, web portals, e-consults and messages. The use of telephone and videoconferencing means are on the reverse synchronous modalities of communication. In healthcare, teleconsultation is geared towards breaking the distance barrier as an obstacle during treatment using computers such as handheld smartphones or desktop computers. Sometimes, teleconsultation is interchangeably referred to as 'remote consultation' due to its ability to connect parties at their extreme locations using telecommunication technologies and is part of telemedicine. Telemedicine on the other hand may be considered to be a form or subset of telehealth (WHO, 2010). Teleconsultation may involve: health care provider (HCP) to health care provider consultation (HCP), physician to physician consultation (P2P), physician to primary care provider consultation (P2PCP), health care provider to patient consultation (HCP2Pt), physician to patient consultation (P2Pt), primary care provider to patient consultation (PCP2Pt) or (Pt2PCP2P), a combination of the patient, the primary care provider and the physician (Deldar, Bahaadinbeigy & Tara, 2016).

E-consultations is one of the applications of teleconsultation as mentioned above. E-consultation is the use of electronic systems, commonly web-based, to enable asynchronous communication between an expert and a client seeking a certain service and comes with various advantages. However, it is worth noting that e-consultations system can be developed to run on both mobile phones or desktop computers. In healthcare E-Consultation usually involves a doctor or medical expert who can communicate on a computerized system with the patient who seeks treatment remotely. These E-consultations in healthcare are sometimes simply referred to as 'e-consults'. The main aim of e-consults is usually to enable the patient access healthcare from their care givers without the need for a physical visit (Vimalananda et al., 2015). In E-consultation and mobile health solutions, various telecommunication and information technologies may be applied to enable implementation of far reaching systems. Some of these technological systems, for example in E-consultations, make use of emails, telephone calls, videos or combine all of them to create a patient-doctor relationship (Catapan et al., 2020). Most of these technologies incorporate the use of large networks of computers connected together from various geographical locations worldwide. Internet is one of the global networks that E-consultation and telehealth in general usually depends on. Actually, just like many other sectors, internet has brought convenience in healthcare delivery for example through remote consultations. Interest in remote based health care is thus rising due to the cheaper virtual visits that it enables (Dorsey & Topol, 2016).

Implementation of E-consultations systems in healthcare has been perceived to be better by both patients and care givers when compared to physical consultations. A study by (Vimalananda et al., 2015) showed that over 70% of health care givers were highly satisfied with E-consultations. Patients who were identified from surveys during their

study also got satisfied with e-consults due to the convenience of electronic consultations. Video consultations being part of most e-consultations is an opportunity for both the medical expert and patient. However, for Video consultations to work and be accepted, they should be improved to cater for patient needs (Johansson, Lindberg & Söderberg, 2017).

There are however, few concerns that come with use of E-consultations in healthcare. One of the major concerns is security of patients' data that is stored and transmitted online through e-consults (Liddy et al., 2013). Control of 'who' has access to 'what' kind of patients' data, accuracy of conveyed information and ability to use the data when needed by the user is therefore necessary. Another one is that some professionals in health sector also fear that 'e-consults' may lead to work overloads or even job replacement. These fears can be best mitigated by developing consultation systems that are highly efficient, secure and user centered. Even though these fears are associated with e-consultations they may also be present in other modalities of teleconsultation.

Purely Synchronous modalities can also be opted in Mobile health applications to facilitate teleconsultation. These applications mostly strive to achieve real-time communication, such as through videoconferencing and telephone calling, and have in the recent years grown remarkably as the penetration of mobile devices and internet has continuously increased. Such applications are also part of teleconsultation and are very helpful in providing solutions to day to day life. However, in most cases teleconsultation system may be implemented having both asynchronous and synchronous capabilities. This study will seek to implement a teleconsultation solution for DEKUT Medical Centre using either or both asynchronous and synchronous modalities.

DEKUT Medical center is the medical clinic for Dedan Kimathi University of Technology. Dedan Kimathi University - DEKUT, is a public learning institution located in Nyeri County, along Nyeri - Mweiga Road. This Clinic is usually located inside the university where it cares for sick students at the university. Access to health care is one of the universities' priorities. Every Student joining the university is registered and cleared at the medical center to enable him or her receive treatment later in case an illness occurs in future. Students who are registered with the universities' medical center can make visit to the health facility to get medical treatment when sick.

However, accessing health care at the facility is not as easy as it might seem for some students in the university. Students living outside the university in private hostels located far from school find it more challenging when sick. These students have to travel or walk from their distant places of residence or hostels and visit the Medical center to seek treatment when unwell. Those living in towns like King`ong`o and Nyeri which are even more far away from the university have to board a vehicle to the institution just to get a prescription from the school yet there are chemists near them. Upon arrival at the university, the sick students are checked at the gate and then head to the medical clinic. At the clinic, students are required to visit the records' office first where their details such as name and registration number are asked, a process which is time consuming. The students are then directed to sit in a queue, at the clinic`s waiting bay, while their physical file is being retrieved from the records room and being handed over to the clinical officer(doctor). The physical file for each student gets processed in a first-come first-serve basis. When the student's turn reaches, the student is allowed to go into the doctor's office whereby he or she narrates his or her symptoms for prescription. A physical prescription, written by the doctor on paper, is then given to the student who submits it at the

school's pharmacy located within the campus medical center for issuance of medicine. The sick student finally leaves the medical center for a journey back to his or her place of residence. Access to health care is thus a crucial need for all students in the university The Medical clinic is thus one of the most important facility in the campus for sick students and hence needs a solution to ensure convenience.

The proposed system will be owned by the university and will enable sick students access healthcare from their places of residence. The system will be android based and accessible through their smartphones. It will borrow most aspects of the teleconsultation modalities discussed above. University students, who are unwell, and the clinical officer/doctor will be the main users of the system at the medical clinic. The system will enable students to register if it is their first time after installation of the application. After registration, student details will be saved in a database for future login. Students registered with the system will have an opportunity to seek treatment remotely. They will no longer have to travel for longer distances to the school while seeking treatment yet there are chemists near them. The system will also involve the clinical officer who will be ready for virtual medical consultations with the ill student. This system is expected to utilize both asynchronous and synchronous modes of communication to help sick students access healthcare at the university.

Upon login, sick students will have the capability to send a chat based description of the illness they are facing. The clinical officer at the university, if not serving another student, will give a response by replying to the chat, else the student will have to wait until he or she is done with the current patient as of that time. The clinical officer while at the university's clinic, but remotely connected, may decide to ask the sick student more questions via the chat feature that will be created or optionally make a video call with the student. This way, the clinical officer will be able to get a vivid understanding of the student's condition.

When done, the clinical officer will give an appropriate prescription. The prescription will be conveyed to the sick student electronically. At the student`s end, he or she will be able to download the prescription in a portable document format (PDF). During the entry of the prescribed medicine into the system, the clinical officer will also key in important information such as the cost of each medicine and the type of the medicine. The input values entered, which represent the cost of the medicine, will enable the system to compute the total costs of the prescription for the sick student. The total costs of the prescription will then be sent to the sick student using an SMS. The application will in addition visualize to the student, a chart or graph, showing the progress of taking the medication from the day the prescription was sent.

In conclusion, it is evident that teleconsultation can be implemented in various modalities to break distance barriers in health care. Through synchronous and asynchronous communication between the medical expert and the patient, physical visits are made completely unnecessary in this era of telemedicine. Students at Dedan Kimathi University are usually met with the difficulty of accessing health care from their far places of residence. Students with minor illnesses that are not emergencies do not have to make tedious journeys to the university clinic. Travel costs and tediousness for sick students who are in search of medical treatment is apparent. The teleconsultation system to be created during this study will be an opportunity for both the students and the learning institution. Through the system, convenience and pervasiveness will be realized since students at Dedan Kimathi University of Technology will have access to

healthcare at any place and any time; considering the fact that almost every student has a smartphone. Additionally, implementation of the proposed system is going to make the entire process of the student getting the medication from the clinical officer as effortless as possible. The System will also reduce travel costs incurred by the sick student`s, residing far away from school, when seeking medical treatment from the university`s medical clinic.

1.2 Problem Statement

Sick Students at Dedan Kimathi University have to physically travel to the medical Centre to seek treatment. Those not within the university's environs are met with relatively high costs of fare, that sometimes keeps fluctuating, when making their journey to the learning institution`s clinic. Higher travel costs incurred by the sick student are thus evident. A lot of time is also wasted by the sick student while waiting to board a Public Service vehicle or bus from place of residence. Upon arrival at the medical Centre, the student undergoes a process which is somehow tedious as the student must first visit the records office before proceeding to the Clinical Officer`s office for prescription. In conclusion, the entire process of seeking treatment can be summarized to be relatively expensive in terms of travel, time-consuming and relatively tedious for the sick student. Existence of these challenges is what prompts the need for this study.

1.3 Purpose of the Study

The purpose of this study is to create a mobile-based teleconsultation system that will yield convenience for students who seek treatment at the medical Centre located in Dedan Kimathi University of technology.

1.4 Objectives

This study will be guided by the following objectives;

1.4.1 General Objective

The main objective of this study is to develop a mobile-based teleconsultation system that will enable remote doctor-to-patient communication in a manner which is effortless for sick students at Dedan Kimathi University of Technology, Nyeri Main Campus.

1.4.2 Specific Objectives

The teleconsultation system will be able;

i. To register new users of the system.
ii. To authenticate the sick student and the doctor/clinical officer before access.
iii. To enable student to doctor communication through text(chat), images and video calls.
iv. To facilitate online prescription by the doctor to the sick university student.
v. To compute the total costs of prescription issued by the doctor to the sick student.
vi. To send medicine-cost information to the sick students for him or her to purchase the medicine from a nearest chemist.

1.5 Research Questions

i. How will the system register its new users?
ii. How will the system authenticate the students and the clinical officer?
iii. How will the doctor/clinical officer and the sick student communicate?
iv. How will the system facilitate online prescription by the doctor to the sick university student?
v. Why is it necessary for the system to compute the total cost of prescription issued by the doctor to the sick student?
vi. Why is the current process of acquiring treatment by the sick student, more tedious when compared to purchasing from a nearest chemist after receiving prescription messages?

1.6 Scope

The creation of a mobile based teleconsultation system will be the main reason for this study. The consultation system will only be used by Dedan Kimathi University students and the clinical officer at the Nyeri main Campus, located in Nyeri county along the Nyeri - Mweiga highway. This system will enable registered students to access health care seamless within and outside the university. Students not registered with the system will not have access to it. Upon completion, the system will be owned by the University. The study for this system will be undertaken for a period of 6 months, at the learning institution, at an estimated cost of KES 117,575. The proposed system will be implemented through an android application. The system is expected to cover: registration and authentication of its users, remote student to doctor communication via multimedia, sending of Online Prescription by the doctor which are downloadable, computation of totals for prescribed medicine and sending of Prescription messages with total costs for the student to purchase from a nearest chemist, as well as visualization of dose completion progress. The system will however not locate the nearest chemist for the student. It will also not be integrated with any electronic health record as student's data or records will be collected and created starting from the time they start using the system.

1.7 Research Site

This study will be undertaken in Dedan Kimathi University of Technology, a public learning institution in Kenya. The campus is located in Nyeri County in Central Kenya. Students living within and outside the institution will be involved in this study. This university accommodates students who are usually studying various courses. A majority of the students usually reside outside the university in private hostels.

1.8 Assumptions

In conducting this research, the following assumptions will be made. It will be assumed that;

i. The intended respondents will be ready and available to be involved in the study at the time when needed.
ii. The respondents to be involved in the research will answer all questions in the research instrument truthfully.
iii. Every respondent to be involved will understand the questions of the research instrument fully before giving their responses.
iv. Sick students, who visit or have ever visited the medical clinic at the university, own a smartphone and have access to the internet.
v. A sick student can be able to use a mobile device while he or she is ill.
vi. A sick student can purchase the right medicine from a nearest chemist after receiving a prescription.

1.9 Limitations

The study is likely to be met by the following limitations;

i) This study will not completely eliminate the need for a physical examination by the doctor. This is because sick students with major illnesses may have to present themselves physically for medical lab examination.
ii) The covid19 pandemic also remains one of the greatest challenge that may face this study. In case covid19 persists, more resources may be required to conduct the study especially when carrying out data collection. This is because a lot must be done to ensure that all tasks and activities are undertaken will observing covid19 guidelines. In case of an increase in covid19 cases, government directives that may lead to closure of the institution, where the study will be undertaken, are also unpredictable.
iii) There is also a possibility of time constraints on certain activities of the project. Some tasks may be completed within shorter time frames to meet the deadlines of this study.
iv) Due to the fact that the study is self-sponsored, budget constraints might force the research to be limited only to the scope outlined on this document and hence any other investigation relating to this enquiry that arises thereafter may be difficult to carry out in depth.

1.10 Significance of the study

This computerized system will to begin with be of great benefit to students with minor illnesses. Sick Students within and outside the university will be able to connect to a medical expert effortlessly for treatment. An ill student does not need to visit the clinic physically, and hence elimination of tedious queueing at the bus station or within the clinic facility. Travel costs will thus significantly reduce for students who make relatively long journeys to the campus medical clinic just to seek treatment. Accessing health care could therefore become fascinating since the student may be able to get a prescription at the comfort of his or her bed. The ability of the doctor to send online prescription and messages with cost information of the prescription, through the system, might even mean that the sick student will only have to make a few steps to the chemist which is nearest and purchase the right treatment within a shorter time. The university will also gain a lot from the data collected during the research process since it may be used to make critical decisions related to the school`s health facility

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Literature review is the second Chapter of this document which discusses previous works related to this study. Scholarly articles from Google scholar, books, journals and credible websites are some of the sources that will be surveyed to generate relevant information. Some of the keywords to be used during the search of relevant sources include one or a combination of the following words in the search phrases: teleconsultation, telehealth, online health, m-health, remote consultation, e-consultation and telemedicine. Literature sources written in English are the ones to be considered for the review. Case studies will form a larger part of this chapter as they will be used to form a comprehensive analysis, enable critiquing of previous works and help generate new ideas. The case studies will be independent from each other and will also be compared for strengths and weaknesses. Any gaps that exist in the literature will be noted down under the research gaps section of this chapter.

2.2 Case Studies

Case studies are very important methods in theory development for example in instances where statistical methods may appear insubstantial (George & Bennett,2005). Through case studies, existing implementation of previous works on teleconsultation systems can be looked at in depth. Case studies also give room for a thorough comparison between various cases. The following case studies in this literature chapter will seek to expound on some of the successful implementation of systems that are closely related to the proposed one. The Strengths of each case will be distinguished as well as their weaknesses drawn. Some strengths of cases, that are achievable with the proposed system may be adopted. The weaknesses of each case will be pointed out to form a learning point for the development and implementation of the proposed system. The cases will also try to point out the dates or years of initial implementation as well as the main goal that necessitated the development of each of the system associated with the respective case. These cases include;

2.3 Case Study One: Udok consultation System in South Africa

Udok consultation system is a teleconsultation system owned by Udok, a startup company, that caters for its patients in South Africa (Digestafrica, n.d.). The system makes use of both asynchronous and synchronous modes of communication with its patients. The consultation system was started around 2017 and is still in use. This medical system is available for both web and android platforms within which it runs. Udok is strongly committed to connecting clinics in its country. One of its greatest achievement is the integration of Electronic Health Records. These records are usually available anywhere for registered patients and can be exchanged between various clinics who have partnered with Udok. Through the platform one can reach the doctor at a paid fee. Communication between the doctor and the patient usually happens via telephone, chat or video calls within which medical advice and prescription is given. Interested patients must pay first to access the medical specialist (Malinga,2020). The patient is also required to first sign up during the first encountered with the system. However, for one to register one must provide the south

African id number or passport number as well as provide an email. The email given, is used by the company to send marketing alerts and help patients receive commercial notification. After registration the patient is then directed to fill a form that collects personal details. The details are used to update the medical profile of the newly registered user. However, before each consultation with a doctor or general practitioner, the patient must fill a questionnaire generated by the system with the intention of understanding him or her better. This becomes monotonous for the sick patient. In my view, the patient should be at most be prompted to update his profile once. If required, a more interactive way should be chosen when collecting details about the patient.

Strengths

Udok yields most of its power from a rich user interface and a seamless video conferencing between the doctor and patient. Its website for example is very intuitive at first look for its users. Udok also boasts of electronic health record integration into its system. Patients can access their medical records nationally from anywhere whenever needed. The data can be widely shared to all clinics that are aligned and connected to Udok`s system. Their platform is also versatile as it provides both asynchronous and synchronous communication through chats and video conferencing respectively. In addition, consultation requests from patients are queued using smart tools which are AI based. The system is also available on multiple platforms that is, web and android.

Weaknesses

The Udok system is to begin with very complex. A lot of integration of health records is needed to implement such a system owing to the fact that it links many clinics in South Africa. The system is posed by security risks that may be present since the data is sharable to any of the clinic that have a partnership with Udok. Secondly, system services are also not free. Patients must pay before accessing consultations after registration. Thirdly, there is monotony on patients before undertaking a remote consultation. The patient is required to fill a system generated questionnaire every time he or she wishes to have a consultation. This should be replaced with a more interactive approach.

2.4 Case Study Two: Teledoc site in the UK

Teledoc was implemented successfully in the UK since 2013. Teledoc was initially created with the intention of being a game changer in medicine in the UK. Its main aim was to restructure the way patients and doctor interacted as of that time. The need to eradicate face-to-face consultations was its main motivation that led to its existence. Patients who are ill usually start their journey of consultation by visiting Teledoc`s website. At the website patients are able to search information about their prevailing condition. Some of the tasks that are undertaken by the patients include: running queries about an illness, receiving advice from medical experts as well as using the help functionality to get assistance from managerial staff. However due to the fact that initial consultation usually involves describing your condition as the patient on a boxed form with limited characters, not all patients are able to elaborate their medical problem. As stated previously, there is also the search functionality. During the search, a patient usually has an opportunity to make a telephone call for advice. The patient can also choose to view pharmaceutical information that results from the query they have just run; including the kind of medicine that can help them recover from their respective illness. Patients who choose to request for medical advice via the system are necessitated to wait for up to

24 hours, since the time they are placed, before their wishes are acted upon. However, the system is typically operational on a 24/7 basis. Probably this should be an advantage to Teledoc although on the reverse there are lots of workloads (Casey, Shaw & Swinglehurst, 2017).

Strengths

Teledoc site operates on a 24 hour/7day basis. Its therefore available at any time for patients. Patients with a specific intention can search their conditions from the system and get almost any information about their illness including the right medicine for them. Customer support via the help functionality for patients having difficulties when accessing medical services through their system is also evident as one of the strengths of Teledoc.

Weaknesses

The online filled form is one of the tools that is solely depended upon for consultation by the patient. This site thus lacks real time communication capabilities for the doctor and patient to communicate. There is also a slow response form the medical expert. In fact, it takes a whole one day for the patients request to be processed and replied to by a medical expert. Those who visit the site must also have a specific reason in mind as they proceed to search for their condition. Patients without the medical expertize may thus search the wrong information as well as acquire the wrong medicine. Use of a less interactive method to evaluate the condition of the patient is also a great drawback for this system.

2.5 Case Study Three: Mehiläinen`s chat-based Application, Finland

Mehiläinen is a clinical company in Finland that applies telemedicine to enable patients access doctors when need arises. Mehiläinen is a well-established company that is privately registered in Finland and boasts of over one million patients distributed in different geographical locations. The chat application for Mehiläinen`s clinic, OmaMehiläinen application which was initially developed in 2016, is basically engineered to support chat functionalities for the patient and the doctor. Patients usually access medical care on the app on a 24/7 basis. The mobile application is developed to run on smartphones and tablets. It has an intuitive design which is simple to use for patients. This user friendly User interface is thus one of its strong holds.

Patient to doctor consultation for OmaMehiläinen application usually begins with a symptom assessment. Patients who wish to consult have a choice of starting the assessment by sending a text or image to the doctor. They can alternatively choose to select a broad symptom from a list provided by the applications interface. Those who choose to select a broad symptom from the application must answer few questions to elaborate on their condition. On the other hand, the chat functionality involves the doctor and the patient engaging in a question-answer conversation. The doctor asks these question continuously until he or she understands the patient`s condition to the fullest.

The chat functionality of this application is reinforced and backed by Slack. Slack is a collection of messaging APIs that collectively form a platform to support instant messaging. Slack also supports quick sending and receiving of multimedia files I real-time. Slack is very efficient in handling online conversations for peer to peer communication. Additionally, slack offers persistent chat rooms sometimes referred to as channels. These channels are well secured

and help create private chat rooms. Slack is written in C++, JavaScript, Objective C++ and Objective-C but can be integrated into an android application. It is therefore evident that Mehiläinen application is a well-established application that specializes with the chat functionality (Mehiläinen Digital Clinic, 2020).

Strengths

Mehiläinen`s clinic application has one of the best persistence when it comes to the chat functionality that is implemented majorly on this application. A thorough integration with slack makes it better in terms of seamless exchange of multimedia based files from the patient to the doctor for consultation. The application also provides an interactive way of gathering the symptoms of the patient by either selecting a broad symptom that matches the patient's condition and then answering a few follow up questions to get more details or optionally using the question-answer chat functionality. The user interface is also outstandingly simple, easy to use and intuitive. Last but not least, the application prides itself of being operational on a 24/7 basis as well as being integrated with the Electronic Health Records(EHR).

Weaknesses

This application is only founded entirely on the chat functionality. The application does not support real time video consultation for its patients. The doctor must therefore be keen to understand the patients chats or continuously ask him or her various questions to know the medical condition affecting the patient. The integration with the Electronic Health Records is also complicated.

2.6 Case Study Four: Valentis` Dial Daktari, Kenya.

Dial Daktari is a paid teleconsultation platform that easily connects doctors and patients around Nairobi. The platform provides telephone consultations which are also integrated together with the Valentis health application. Dial Daktari is owned by Valentis Health, who have partnered with Telkom Kenya to offer its customers an affordable remote medical consultation. Valentis Health is a leading company in Telemedicine not only for Kenya but also in other countries. Dial Daktari was implemented in 2020 and is expected to continuously reach patients all over Kenya. The implementation of Dial Daktari in Kenya has been accelerated following the onset of the covid19 pandemic which restricted most movements around the country. The tele-medical service is aimed at enabling Kenyan patients, and especially within Nairobi, access health care at the comfort of their homes with little risk of covid-19 infection spread (Benson, 2020).

Just as its name suggests, Dial Daktari enables Telkom Kenya customers who are its main patients, to access the doctor by calling a toll-free number through their mobile phones (Telkom Kenya, n.d.). However, before reaching out the doctor, Dial Daktari patients must first contact the care manager. The care manager then assigns and directs the patient to a qualified doctor who is registered with Valentis remote consultation service.

Dial Daktari is usually integrated with an Android application which is dedicated to tracking the patients and offering consultation via alternative forms such as video and text. The applications interface allows patients to key in their symptoms, sleep patterns, the food they eat, blood pressure, temperature.as well as other medical details. Patients also

have an opportunity to download and upload medical reports such as prescription PDFs and images. The patients profile details are also saved and are related to the patient's health. Customers of Dial Daktari usually pay through T-Kash pay-bill for medical services to be received through the platform (Benson, 2020).

Strengths

Dial Daktari offers a flexible way of accessing the doctor. The patient can choose to tele-consult via the telephone call using a free Telkom number or optionally use Valentis` health application to schedule and have both text and video based consultation. Dial Daktari is also operational on a 24/7 basis and hence patients can access the service virtually almost at any time. Payment is also automated via T-Kash pay-bill functionality for Kenyan patients the tele-medical consultation.

Weaknesses

In Dial Daktari, patients seeking to consult with the doctor via the toll free number must first get served by the care manager who then assigns the patient to a doctor. This results to a triage involving the patient, the care manager and the doctor. This triage may be a bit unbearable for some of the sick patient since the care manager may serve those with serious conditions before those with minor ones. Those with minor illnesses must therefore be patient enough while waiting to be assigned a doctor by the care manager. Last but not least, the toll free calling is only available to Telkom Kenya customers.

2.7 Case Study Five: mDoctor Android Application, Bangladesh

MDoctor is a mobile teleconsultation android application developed by ITmedicus in 2019. ITmedicus is specialized with creating online mobile solutions in healthcare. mDoctor was developed to avail medical services to the sick patients easily and at an affordable cost through their mobile phones. The mDoctor application runs on android operating system whereby sick patients usually get treated by consulting with the doctor remotely.

The application is developed using Kotlin, a recently developed java virtual machine kind of programming language as well as other prominent libraries such as: glide, ReactiveX and reactive streams, gRPC and Google gson. Glide is an image loading and caching library and has been used to implement perfect scrolling of items. For asynchronous programming ReactiveX together with reactive streams library has also been employed. Real time communications especially the video consultations are dependent on the android gRPC which is an open source framework owned by Google. The gRPC framework provides powerful streaming capabilities for the mDoctor application. Java to json object conversion and json to java conversion is done by the Google gson library.

Through mDoctor, a patient can schedule an appointment, consult with the doctor through video calling, send medical details including pictures and previous lab reports as well as receive a digital prescription. mDoctor is therefore basically focuses on video consultation between the doctor and the patient.

Consultations in mDoctor usually start with the patient who schedules for an appointment with the doctor. The application allows the patient to select or search from a long list of many doctors. This list of doctors is categorized

according to the given specialty that the patient may wish to seek treatment from. When reserving an appointment from a selected doctor in the list, a profile of the doctor with details such as; the picture and name, price to be paid by the patient, time when available as well as the medical proficiency is displayed to the patient before confirming to take the appointment. The application also displays a list of all scheduled appointments. Scheduled appointments by the patient can also be cancelled before they take place. After the consultation is complete, the patient is sent a prescription to his phone (MDoctor, 2019).

Strengths

The mDoctor application offers seamless and reliable video consultation functionality which is easy to use for any patient. The user interface provided by the application is also simple. Additionally, one can quickly schedule appointments with the doctor as well as cancel scheduled ones.

Weaknesses

Selection of the doctor from the list requires the patient to evaluate the correct specialty that fits his or her condition or optionally search a specific doctor that he or she knows. There also lots of unnecessary information provided during the scheduling of the appointment. The application should therefore assist the patient pick the right doctor easily, reduce memory load on the patients, as well as limit the length of the list to be displayed at first in the application's interface. Additionally, the application only supports video consultations as the main modality of accessing remote consultation by the patient. In instances when the patient is in far-flung areas that have limited bandwidth within their network, this service would not be easy to access. A chat functionality, which is not present in this application, would have come to rescue in such a scenario whereby patients are experiencing slow internet access.

2.8 Research gap

Although there are many studies done on teleconsultation in other countries, few studies have been done on the implementation of teleconsultation systems for students in Kenyan public universities. Most of the teleconsultation studies have also concentrated on the doctor instead of the patient. The doctor or medical expert has in most of the cases been seen to be the driver of the teleconsultation. Most studies on teleconsultation systems have also been seen to necessitate the patient to pay for the teleconsultation service before access. This study will be DEKUT specific and will greatly focus on enabling the sick student, who is the patient, access consultation services remotely with ease and least effort through a teleconsultation system. The study will yield a system that will be free to all students at the university. Through this study, students' experiences at Dedan Kimathi University of Technology with the physical face-to-face method of receiving treatment at the institution's medical clinic will also be understood before creating the system.

2.9 Conclusion

In conclusion, it is evident that implementation of teleconsultation systems has worked in many other countries as a mode of accessing healthcare. The cases reviewed in the literature review also show that there are both similarities and differences present in the implementation of teleconsultation systems. A common goal that has been identified in all the cases is the need to provide medical experts virtually to patients via a computerized system. However, most of the cases identified have also differed in certain aspects such as: method of symptom assessment, the user interface,

consultation modalities, location of implementation as well as the strengths and weaknesses. The following table below, draws a brief summary of each of the case covered for comparison against each of the case.

Table 2.1: Case Studies Comparison

Case Study	Use Status	Key Features	Strengths	Weaknesses
Udok, South Africa	Still in use	Assessment forms, Chat and video calls	✓ Rich UI. ✓ EHR integration. ✓ Seamless video conferencing. ✓ Multiplatform. (android, web) ✓ Smart patient request queueing.	➢ Paid ➢ Complex EHR integration ➢ Monotonous patient assessment
Teledoc site UK	Still in use	Condition Search functionality, assessment form	✓ Avails large information for patients to search. ✓ Operational 24/7. ✓ Displays pharmaceutical information of medicine.	➢ Slow response from medical expert ➢ Less interactive
Mehiläinen`s app, Finland	Still in use	Symptom assessment, Chat functionality	✓ Persistent chat functionality. ✓ Interactive symptom assessment	➢ Solely dependent on chat functionality
Dial Daktari, Kenya	Still in use	Telephone Calling	✓ Flexible means of communication.	➢ Unbearable triage by patient. ➢ Toll free calling only available to Telkom customers
MDoctor app, Bangladesh	Still in use	Video conferencing	✓ Superb on video consultations. ✓ appointments can be made or cancelled easily. ✓ Simplicity.	➢ Solely dependent on video calling for consultations ➢ Memory load when searching the right doctor.

CHAPTER THREE: METHODOLOGY

3.1 Introduction

The third chapter, methodology, stages a description of the procedures and research methods to be followed and used respectively during this study. The chapter basically includes the following topics; research design, data collection methods, the target population, sampling and sample size, data analysis methods, software development method, justification for methodology, ethical consideration as well as a brief chapter summary.

3.2 Research design

Case studies on previous systems are to be used in literature review. The case studies will highlight the strengths and weaknesses of each system. Field research methods will also be employed in primary data collection for the study. This study is specifically intending to use an online descriptive survey to collect the primary data from students at Dedan Kimathi University. Responses by the students will be identified and their frequency counted. This will to better understand students who have ever been sick and treated at the medical clinic. These students who will be surveyed online will be the participants of the study relating to the university`s medical clinic. A positivistic approach which will be quantitative will be majorly utilized. The research will seek to solve an immediate problem facing students at the university and will thus be an applied type. The reasons for this research design is that; it will help the investigator collect as much data as possible with little costs through an online platform. It is thus expected to be an economical research design for the study at hand. Analysis of the collected responses will also be quicker hence less constraints on time. It will also try to observe the covid19 measures and guidelines put in place by the ministry of health by reducing contact with the survey participants. However, a big limitation of this research design is that the online survey which will be used is to lose the physical interaction which helps identify students feeling and emotions when answering questions.

3.3 Data Collection methods

Primary data will be mainly collected for this study. Some secondary data will be collected from books, journals, articles and credible websites. The secondary data sources will however, be majorly used to complement the literature review chapter of this document. The following instrument will on the other hand be used to collect primary data from the target population;

3.3.1 Questionnaires

An online questionnaire, via Google forms, will be disseminated to students during the survey of this study. The questionnaire will have both open ended and close ended questions to help achieve the objectives of this study. Open ended questions will require the respondents to fill in their responses in a statement form, such as short sentences, while close ended ones will have choices for the participants to pick from. The validity of this study tool will be guided by the study Objectives as outline in Chapter One as well as the advice from the supervisor. A sample of the online

questionnaire has been attached at the appendix of this proposal for reference but may change accordingly during actual data collection to accommodate for any necessary requirements that may arise. The main reasons of using online questionnaires is that;

i. The responses of the questionnaires filled by the students will be easy to quantify through use of existing software and platforms such as Google Forms, Microsoft Excel and many others.
ii. The instrument will collect large amounts of information quickly and economically from the students and especially during the covid19 times.
iii. The instrument is researcher- independent as it can be administered by someone else and still retain its validity.

3.4 Target population

The target population for this study will be; all currently studying Dedan Kimathi University students who attend the medical clinic for treatment. These students will include those in different courses and study years. The reason these students will be chosen is because they will help gather the necessary requirements for designing and developing a computerized consultation system which will be student-centered as it will save them the tedious and travel expensive process of accessing health care. They will also be among the main users and beneficiaries of the system when it's complete.

3.5 Sampling and Sample size

3.5.1 Sampling

Convenience sampling which is a non-probability sampling, will be used in selecting the sample from the target population. The researcher will walk around the university and especially around the medical Centre whereby, the students met will be briefed about the background of the study. Those who choose to participate in the study, will get a link of the online survey of the study for them to fill it at their own time and place. The researcher will use only those students who are readily and easily available at the time of data collection. This sampling technique will be opted due to the limitations of covid19 that restricts the research to be done while observing social distancing guidelines. Some students may also not be available at the time of data collection and hence only those available will be used. The sampling method will also be economical to use since it will not require the researcher`s intervention, which would have been expensive, when choosing the subjects, considering the budget constraints that may face the study. However, a limitation of convenience sampling is that it's not perfectly free from bias as it seeks to use a representative sample which is most convenient to the investigator hence may lead to a false outcome of generalization.

3.5.2 Sample Size

A sample of 60 students will be used as the intended sample size for this study. This sample size is expected to be perfectly representative of the target population. The sample size will inform the number of online questionnaires to be disseminated.

3.6 Data analysis methods

The fact finding process will be reinforced by a comprehensive data analysis to make it complete. Primary data collected from respondents, students, will be analyzed through automated tools such as Google Forms, Google sheets and/or optionally Microsoft Excel to save time. The frequency of certain responses will also be identified and counted from all students who will participate. Presentation of the data will then be made through charts, tables and graphs. Responses from open ended questions of the research instrument that may exist will on the other hand be subjected to thematic analysis.

3.7 Software Development Method

3.7.1 Rapid Application Development(RAD)

RAD will be chosen for the development of the proposed system. RAD is a kind of an agile methodology that insists on a quick, user-centered design and development. This method however, delays the design phase a bit until user requirements are clear.

RAD was introduced in software development to eliminate the limitations of the traditional waterfall model, which was plan driven. One of the greatest limitation of waterfall methodology is that users are not involved in system validation until acceptance testing is done. This is because waterfall has a linear plan driven approach that does not give room for user involvement. The plan used in waterfall must therefore be well thought of before starting the development. Therefore, water fall is only applicable for systems with fixed requirements. For systems that would demand for increased testing and changes in design such as the medical consultation System, waterfall would not be a good option.

On the other hand, RAD is user centered as it prioritizes the use of prototypes after requirements are newly defined. These prototypes may be: Low –fidelity prototypes or high Fidelity prototypes. Low fidelity prototypes are usually mainly physical, for example designs on paper, while high fidelity prototypes are software based ones with great similarity to the actual end product. Basically, most high fidelity prototypes are made using non-code software and may thus lack backend capabilities. The RAD methodology is to be implemented in the following steps;

1. Define Broad Requirements

Firstly, general requirements which are not specific are defined. Users of the system are not required at this stage. This is because the general requirements usually get clearer to both the developer and the client later after user interaction.

2. Prototype

A low fidelity prototype of the system is for the first time created using low level tools such as hand drawn wireframes on paper. In my case; hand drawn screen layouts will be created for the first time during the early design phase. Prototyping software such as Balsamic will then be used to create subsequent and refined high fidelity prototypes quickly after the first user feedback. These prototypes will be shown to the user whereby their feedback is captured.

In case users want something added, the developer then redesigns the prototype for another user evaluation session. The subsequent prototype will usually be better than the previous one, as it results from what was consecutively agreed upon, and may be opted by the user as the final product to be constructed. It is important to note that this 'best prototype' may not necessarily have code behind it and hence may be thrown away upon implementation of the real system. Otherwise, the prototype is refined repeatedly until it suits the needs of the user. This kind of prototyping will thus assume some properties of evolutionary prototyping since the end product will be generated from refinement of initial prototypes.

3. Get User feedback

This step is a usually paramount as it determines when the construction of the final product is to be done. The first prototype as well as subsequent ones, if any, are then gauged by the user. At this step, User and developer interaction is very key and it influences the functionality and visual look of the product.

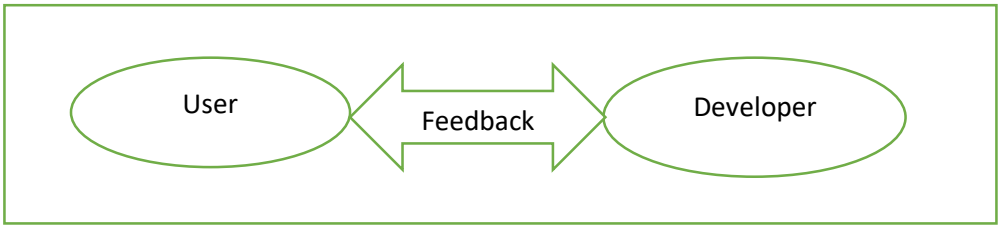

Figure 3.1: User-feedback diagram

4. Construct Final Product

The final product will then be constructed after the requirements are well structured. This end product usually results after a thorough testing with the user. Actually the final product may optionally be derived from the best prototype so far which has been evaluated by the user. Construction of the final product also involves some testing by the developer. Components that are to be integrated are also combined at this stage. These components may sometimes be working together to accomplish a common goal.

5. Deploy

This is the last step of this method. It involves launching of the final product into its working environment. In this stage the software is implemented in a suitable transition strategy. Training of its users may be done at this stage to familiarize with the system before actual use. A diagram illustrating more on the RAD methodology is as shown below:

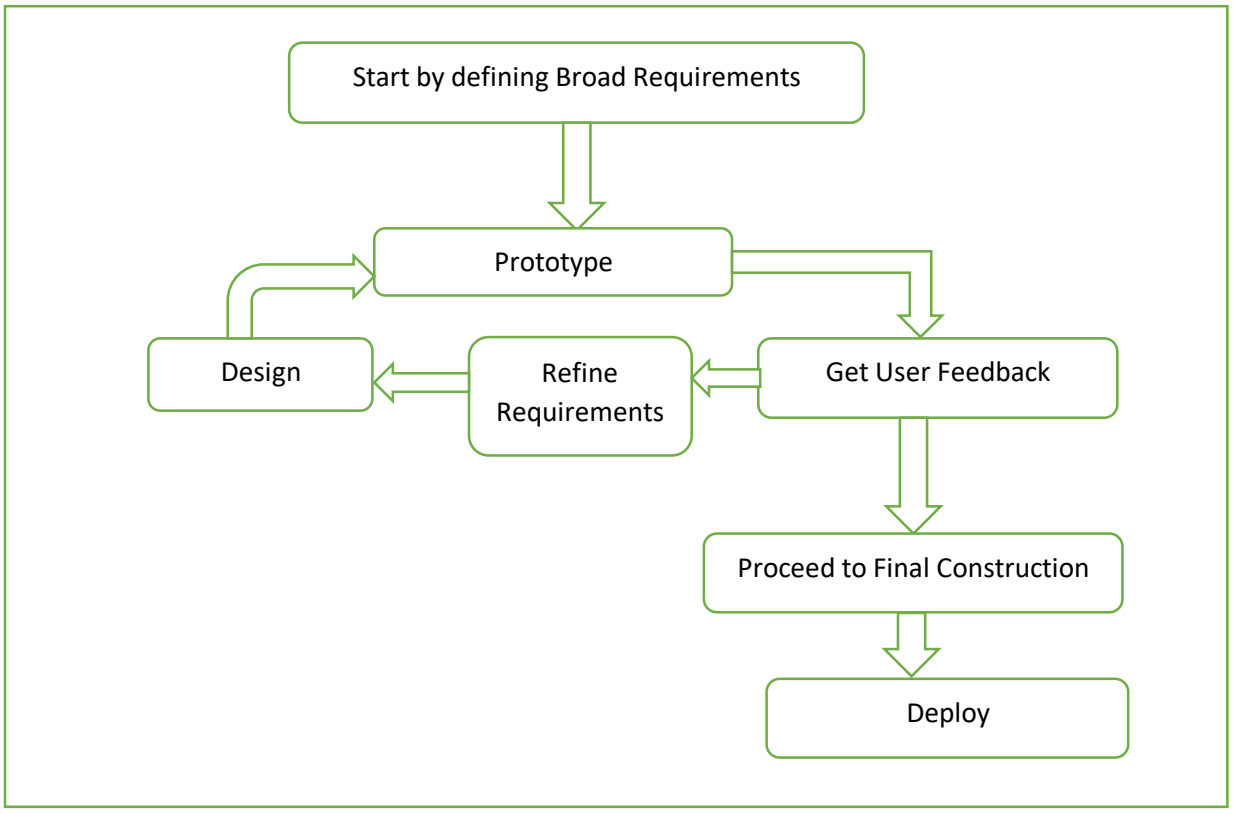

Figure 3.2: RAD methodology diagram

3.8 Justification for Rapid Application Development

One of the main reasons as to why RAD was chosen is its ability to adapt to changes. RAD enables a flexible way of including emerging issues or changes during software development. Additionally, more than one different activities can also be undertaken at the same time as long as they do not interfere or are dependent with each other. In RAD, user requirements are defined broadly and become polished as the interaction between the user and the developer continues. The ability to accommodate a looped user centered approach of this method is what greatly makes it adaptable to changes.

Another reason is that RAD reduces overall project risks through repetitive System validation unlike in plan driven methodologies where the user is only involved during or after acceptance testing is done. Through prototyping, the user gets a vivid image of the functionalities of the software to be constructed. Necessary changes will also be executed early as well as mitigation measures put in place for successful deployment of the consultation system.

Lastly, RAD is also very suitable for a project to be undertaken in a short time frame. This is because RAD maintains quick short development cycles.

3.9 Ethical Considerations

This study will be conducted while observing various ethical concerns. Firstly, Consent will be sought from all respondents who will be involved in the study. None of them will be forced or tricked to undertake any activity designed for this research. Secondly, the details or background of the study will be explained clearly in the research instrument for respondents who are willing to be part of the study, so that only correct information is collected. Thirdly, confidentiality of data to be collected during the fact finding period, will be guaranteed to the best of the researcher`s ability, and will hold the highest priority among other considerations. Lastly, all respondents will be informed in case of any and all personal information that may be collected for the purpose of this study.

REFERENCES

Benson, T. (2020, May 19). *Telkom Kenya and Valentis health partner to offer telemedicine services*. Tech In Africa. https://www.techinafrica.com/telkom-kenya-valentis-health-partner-offer-telemedicine-services/

Casey, M., Shaw, S., & Swinglehurst, D. (2017). Experiences with online consultation systems in primary care: case study of one early adopter site. *British Journal of General Practice*, *67*(664), e736-e743.

Catapan, Soraia de Camargo, & Calvo, Maria Cristina Marino. (2020). Teleconsultation: An Integrative Review of the Doctor-Patient Interaction Mediated by Technology. Revista Brasileira de Educação Médica, 44(1), e002. Epub March 30, 2020.https://doi.org/10.1590/1981-5271v44.1-20190224.ing

Deldar, K., Bahaadinbeigy, K., & Tara, S. M. (2016). Teleconsultation and clinical decision making: a systematic review. *Acta Informatica Medica*, *24*(4), 286.

Digestafrica. (n.d.). Udok. https://digestafrica.com/companies/udok

Dorsey, E. R., & Topol, E. J. (2016). State of telehealth. *New England Journal of Medicine*, *375*(2), 154-161.

George, A. L., & Bennett, A. (2005). *Case studies and theory development in the social sciences*. mit Press.

Johansson, A., Lindberg, I., & Söderberg, S. (2017). Healthcare personnel's experiences using video consultation in primary healthcare in rural areas. Primary Health Care Research & Development, 18(1), 73-83. doi:10.1017/S1463423616000347

Liddy, C., Rowan, M. S., Afkham, A., Maranger, J., & Keely, E. (2013). Building access to specialist care through e-consultation. *Open medicine: a peer-reviewed, independent, open-access journal*, *7*(1), e1–e8.

Malinga, S. (2020, June 24). *Clicks clinics offer video doctor consultation services*. ITWeb. https://www.itweb.co.za/content/LPwQ5Ml6E13vNgkj

MDoctor. (2019, March 26). ITmedicus. https://itmedicus.com/portfolio/mdoctor/

Mehiläinen Digital Clinic. (2020). *Digital clinic brings remote doctor's appointments to you*. Mehiläinen. https://www.mehilainen.fi/en/omamehilainen/digital-clinic

Telkom Kenya. (n.d.). *Telkom customers to access subsidized medical consultation via their phones*. Telkom Kenya Limited | Telecommunications provider in Kenya. https://telkom.co.ke/telkom-customers-access-subsidised-medical-consultation-their-phones

Vimalananda, V. G., Gupte, G., Seraj, S. M., Orlander, J., Berlowitz, D., Fincke, B. G., & Simon, S. R. (2015). Electronic consultations (e-consults) to improve access to specialty care: a systematic review and narrative synthesis. Journal of telemedicine and telecare, 21(6), 323–330. https://doi.org/10.1177/1357633X15582108

W H O. (2010). opportunities and developments in member states: report on the second global survey on eHealth. *Global Observatory for eHealth series*, *2*.

APPENDICES

APPENDIX A: Budget

Item	Description	Unit Cost in KES	Net Total cost in KES	Grand Total Cost in KES	Source of Fund
Stationery	30 blue pens	20	600	1775	Self-sponsored
	10 exercise books (120 pg. books)	80	800		
	15 pencils	25	375		
Internet	30 GB Safaricom bundles	200	6000	6000	Self-sponsored
Printing and Binding	Proposal document	1500	1500	7000	Self-sponsored
	Progress Report	2500	2500		
	Final documentation	3000	3000		
Development Tools	2 Smartphones	10000	20000	65000	Self-sponsored
	1 Core i5 Laptop	45000	45000		
Data Collection	Costs of the research instrument	1000	1000	1000	Self-sponsored
Transport	168 day trips to the university	50	8400	16800	Self-sponsored
	168 day trips from the University	50	8400		
Miscellaneous	Unexpected costs	20000	20000	20000	Self-sponsored
TOTAL IN KES			117,575	117,575	Self-sponsored

APPENDIX B: Gantt chart

Weeks	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17-18	19-20	21-22	23-24
Research Concept												
Literature Review												
Research Proposal												
Data Collection												
Data Analysis												
Prototyping												
System Design												
System Construction												
Progress Report writing												
Testing and Implementation												
Final Report Writing												
Submission of Final documentation												

APPENDIX C: Sample Questionnaire

DEKUT Teleconsultation System Study Tool

Hello, I am ROBINSON MURIKI GITHAE, a fourth year student undertaking a Bsc.in Information Technology at Dedan Kimathi University of Technology, Nyeri Main Campus. Access to healthcare is an important need for any student. Computerized teleconsultation systems in healthcare help a medical expert communicate with a patient remotely. This study seeks to create a consultation system for students at the university so that they can access healthcare effortlessly. The resulting system will be implemented at the university's medical clinic.

Please help me conduct the study by filling this Questionnaire. Feel free to answer the following questions truthfully since all data collected will remain confidential and will only be used in this study.

1. a) Have you ever visited DEKUT`s Medical Clinic?

   YES

   NO

   b) How was the process? (Pick 1 or more choices)

   Effortless

   Enjoyable

   Fast

   Tiresome

\ Boring

   Slow

   c) Give a reason to support your answer in 1(b) above

   ---

2. a) Where do you live?

   Within the university

   Outside the University

   b) Do you use a public service vehicle when visiting the school`s medical clinic for treatment?

   YES

   NO

c) How is the journey to the school`s medical clinic?

Cheap

Very cheap

Expensive

Very expensive

3. How fast were you served upon arrival at the medical Centre?

   Quickly

   very Quickly

   slowly

   very Slowly

4. a) If you have ever visited the medical Centre, were you satisfied with the service at the medical clinic/Centre?

   YES

   NO

   b) Give at least 1 or more reasons for your answer in 6(a)

   ---

5. a) Have you ever used a remote consultation system before to access healthcare?

   YES

   NO

   b) Do you think a remote consultation system would make access to healthcare by University students at DEKUT better?

   YES

   NO

   b) State a reason for your answer in 5(b)

   ……

6. a) Which of these features would you recommend for a teleconsultation system? (pick one or more)

   Telephone call

   Video call

Chat

Text SMS

Image upload

b) Which feature is not mentioned in 6(a) above that you think should be added to a teleconsultation system?

…….....

7. a) What problem(s) do you face will accessing health care at the medical Centre?

   b) What do you think the consultation system can do to solve the problems you stated in 7(a)

   ……

8. Are there pharmacies near your place of residence?
   Yes
   No
9. In case a prescription is sent to your while sick, would you be able to purchase the medicine from the nearest pharmacy instead of travelling all the way to the school's medical clinic?

   Yes

   No

10. Would you prefer a text message being sent to you with cost information of the medicine prescribed, so that you can purchase the medicine from a nearest pharmacy instead?

    Yes

    No