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MODELLING AND IMPLEMENTATION OF A TELECONSULTANT APPLICATION

The impact of mobile application on Telemedicine

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Abstract : **Today, as we are all aware of the current situation that the world is facing, which has got serious implications on our lives, it has changed our traditional systems of doing things like the way we used to communicate, the ways we used to greet and also the ways we used to meet and discuss. The situation created a new normal in which all these things we used to do have gone virtual in online mode. Examples of these are teaching, meeting medical doctors for consultations, meeting lawyers to discuss case problems etc. All such meetings have gone virtual. It is over this backdrop that the proposed system (teleconsultant) seeks to solve by developing an application that can help render the services of the above-mentioned denominations. Teleconsultant is the process whereby people meet virtually and discuss their problems with professionals. The teleconsultant attempted in this thesis enables such meetings with consultants from all walks of life virtually. Clients can discuss their problems with a consultant of their choice through *video calls and chat, and also pay for the service rendered.***

Keywords—Jitsi;Consultant;Android;Firebase;Google\ pay; Virtually;Telemedicine;Video call;chat;BPMN;Collaboration; Network;WHO etc.

I. INTRODUCTION

What is TeleConsultant:

Teleconsultant is the use of electronic means to deliver or access services from a specific Location, to a remote location virtually. We will explain with an example of telemedicine. Telemedicine is the process whereby the movement of a healthcare worker is virtual, that is to say a healthcare worker can meet his or her client remotely without any further distance covered and treat those clients. The proposed system is a health application that is trying to democratize the healthcare sector for all. That is to say each and every one can get access to their healthcare providers across the globe irrespective of background.

The design and development of this teleconsultant provides a robust, secure approach in managing and to maintain a patient health record, and provide accurate communication between a patient/client and a doctor or consultant. It helps to mitigate the redundant flow of patient health data from one location to the next by ensuring that all records concerning the patient are stored in the application and the patient has total autonomy over his/her health data, hence data authorization, authenticity and availability are maintained by the patient. Teleconsultant is a universal set which encompasses telemedicine, teleteaching, telelawyer, where teleconsultant is a border

terminology, which encompasses various sets of technologies like telemedicine, mobile health, teleteaching, teleconferences etc. The main focus of the project is the interconnection between patient and doctor as a key example other as well can use it since it is generic. We use patient and doctor as an example but it is as well applicable to other consultants such as lawyers and their clients, teachers and their students etc.

2.0 LITERATURE REVIEW

The review of past literature of this research is in manifolds, much research has been done in order to see how best tangible solutions are put forward to curtail the problems of telemedicine. In one report, Meso et. al (2012) put forward the solutions to curtail the effective movement of telemedicine in Sub Saharan Africa, in order to upgrade the effective use of telemedicine.

Ronie et al (2012) made a research on Telemedicine, which he defined as the use of Information and Communication Technology in order to provide health care services to individuals who are far apart. The work was not specific as to which service to provide for individuals to connect to their health care providers. Moulin (2012) made a conclusion on Telemedicine that the whole idea about telemedicine is about the connection of health workers to their clients/patients. They also do not discuss as to what accurate technology to use.

Achampong, Marful and Winter (2012) gave a brief synopsis about the use of telemedicine in West Africa, they said West Africa countries actually lack the exposure to readily made healthcare information systems that have hindered the effectiveness of telemedicine in the continent.

Hamilton and Seitio Kgokgwe(2013, 2015), narrated about the development of Health Information Technology in both Tanzania and Mozambique, they shared their experience as to the hindrances of telemedicine in that region.

They said technical capacity is a problem and also the failure not to include the actual users of the system.

The World Health Organization has outlined the significance of end users to a system, that is to say whenever a system is being built the end user should be taken into considerations.

Berg and Coiera (1999, 2011), both of them said healthcare work is a complex task and it requires use of formal and informal work processes and tools. There is the need to develop a healthcare system that is acceptable to every healthcare worker.

Stewart et al (2015) and Sabatier (1986) both explained the tendency for the introduction and implementation for a top-down approach of a new information technology system that is very high.

They said policy experts, administrators in the healthcare sector need to investigate systems or the policies which they believe to be beneficial.

3.0 METHODOLOGIES

3.0 Introduction

A software development methodology is a structure that is used to plan, and control the process of developing an information system, this includes the pre-definition of specific

deliverables and artifacts that are created and completed by a project team to develop or maintain an application. A wide variety of such frameworks have evolved over the years,

each with its own recognized strengths and weakness. One software development methodology framework is not necessarily suitable for use by all projects. Each of the

available methodology structures are best suited to specific kinds of projects, based on various technical, organizational, project and team considerations. These software development frameworks are often bound to some kind of organization, which further develops, supports the use, and promotes the methodology framework. The methodology framework is often defined in some kind of formal documentation. Specific software development methodology includes: Rational Unified Process (RUP, IBM) since 1998 and Agile Unified Process (AUP) since 2005 by Scott Amber.

The development of this project was done using android studio and java end google firebase and the cloud server of which a more detailed explanation of their use and reason of employment is further explained below.

Every software development methodology approach acts as a basis for applying specific frameworks to develop and maintain systems. Several system developments approaches

have been used since the origin of information technology, broadly these are:

1. Software development life cycle methodology (SDLC)—there are many models under these methodologies:

- Waterfall model which is a linear framework.
- Rapid application development (RAD): an iterative framework.
- Spiral: a combined linear-iterative framework. item Incremental: a combined linear-iterative framework or V model.
- Prototyping: an iterative framework

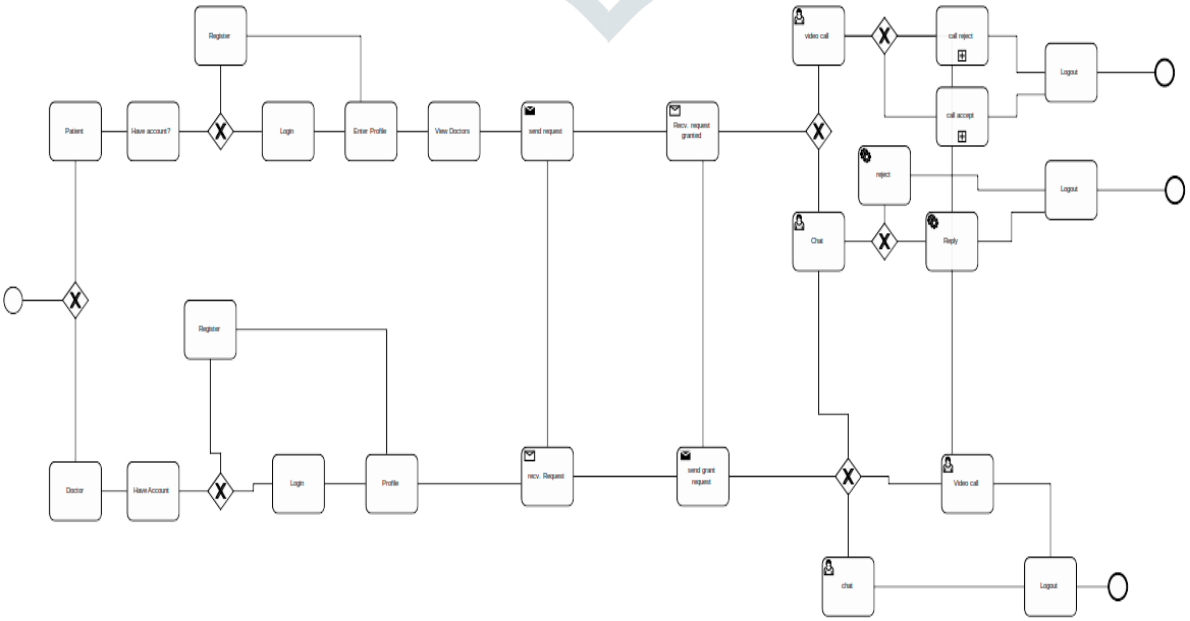
Agile methodology:

- Scrum
- Extreme Programming
- Adaptive software development (ASD)
- Dynamic system development method (DSDM)

BPMN model:

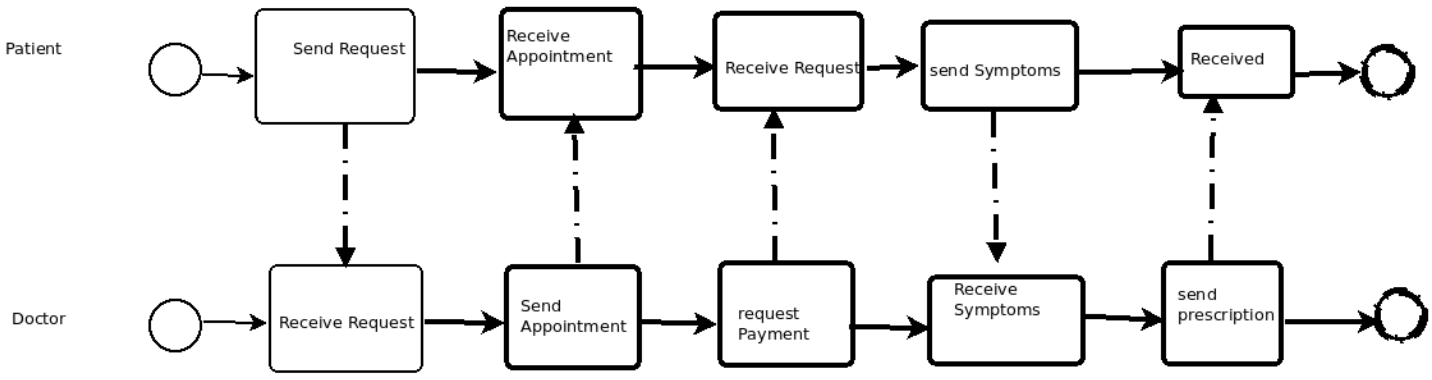
This model shows how the proposed system is going to be operated. At the start of the application, an interface will pop up which shows the options of both patient and doctor. If you are a patient for the first time using the system, you are required to open an account using your email address and user name. After registration you can then have access to the patient profile. If you have already created an account, you do not need to register again, all you need to do is to login with your email address and password. Upon reaching into the patient profile, you are required to edit your profile and upload a profile pic. after which you will then move to the next process by viewing doctors. Based on the profile of the doctors, it is up to you to make your choice by selecting a doctor that you might want to talk with. After sending a request to a doctor, the doctor can choose whether to accept or reject based on the amount of people the doctor might be attending to with. The doctor can send requests granted by accepting the call and send payment requests to the patient. The patient can then receive payment request from the doctor. The patient after making the payment within a minute, the

doctor will then receive a payment notification of the patient and then allow the communication to flow. It might be either through text chat or through video call. After the communication finish, they both might logout from the system. Also, if the patient wants to talk again the patient can login into the system and enter a code which he/she will share with the doctor. The doctor will use the code and communicate with the patient. For the doctor process, just like the patient process, the doctor will either login or register. if he/she has already registered, they might just login into the system, update their profile and wait for any incoming request.



Collaboration Model

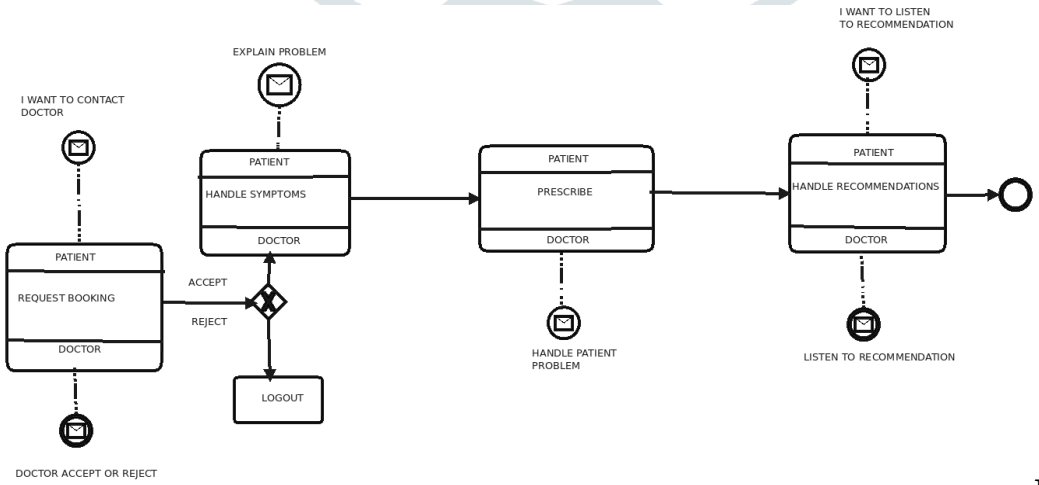
In the collaboration model, here we can see that there are separate pools and lanes for both the patient and the doctor. The patient has its own process which moves linearly so the doctor. The patient can send requests, then the doctor can receive the request, which is shown in the diagram with a dotted line. The doctor after receiving the request, then sends appointment to the patient, which is shown with dotted lines. The patient can receive the appointment, from there, the doctor can request for payment as well, the patient will receive doctor request for payment. After which the patient can then send symptoms or problems affecting him/her. The doctor will receive the symptoms from the patient. The doctor will then send prescriptions or recommendations to the patient, the patient will receive. There the process ends for both patient and doctor.



A Collaboration Diagram Between a Patient and a Doctor

Collaboration between Doctor and Patient Model

In this model we can see that there are two entities, patient and doctor, the patient can send a request to the doctor which is request sending, the doctor can accept or reject the request from the patient. If the doctor reject, the patient can just logout off the system after a specific waiting time. Else if the doctor can accept the request from the patient, then the doctor can ask the patient the problem, the patient can explain the problem to the doctor. After that, the next process will be the doctor handling the patient problem which is a sending message to the patient. The next and final process will be the patient listening to the recommendation from the doctor and then logout from the system.



Patient:

This is responsible for allowing the patient to work through the system. In the patient cholorography, the patient is a single entity which interacts with the system and the system will then give access to the patient after providing the required authentications needed by the system like correct username and password used to register or being used

before to login. For instance, consider a patient as an entity, initially, the patient would open the system

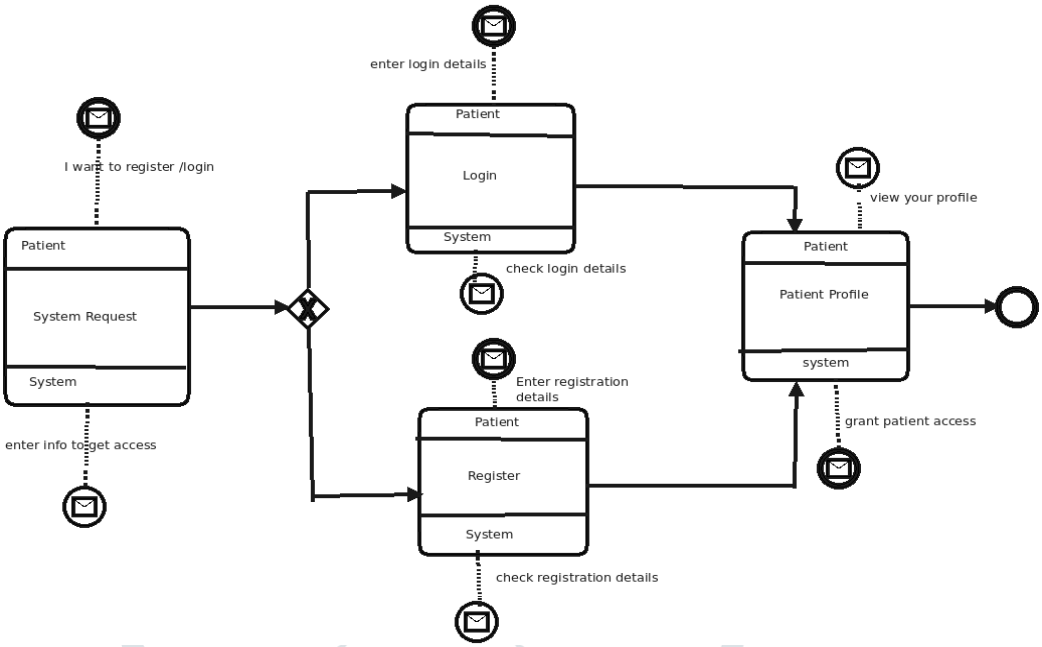


Figure 4:Interraction Between Patient and System

and the patient's intention is to login into the system, the system will ask the patient to provide login details, if the login details are correct the patient will then have access to their user profile, otherwise the patient would not have access to user profiles.If the patient is the first- t i m e user of the system, they should be able to register by providing their credentials like username, email, password and phone number. Then the patient will be granted access into the system. The patient's data is well secured in such a way that information will not be shared about the patient to the outside world.

Doctor

The doctor model is same as that of the patient but the model used is known as the Chinese wall model, this system is well secured and the security model used is the Chinese wall model, that is to say even if same doctors are in the same department, they will not be able to see each other's credentials. The doctor will provide credentials to login or register if haven't done so. If already registered he/she will just login into the system by providing his/her login credentials

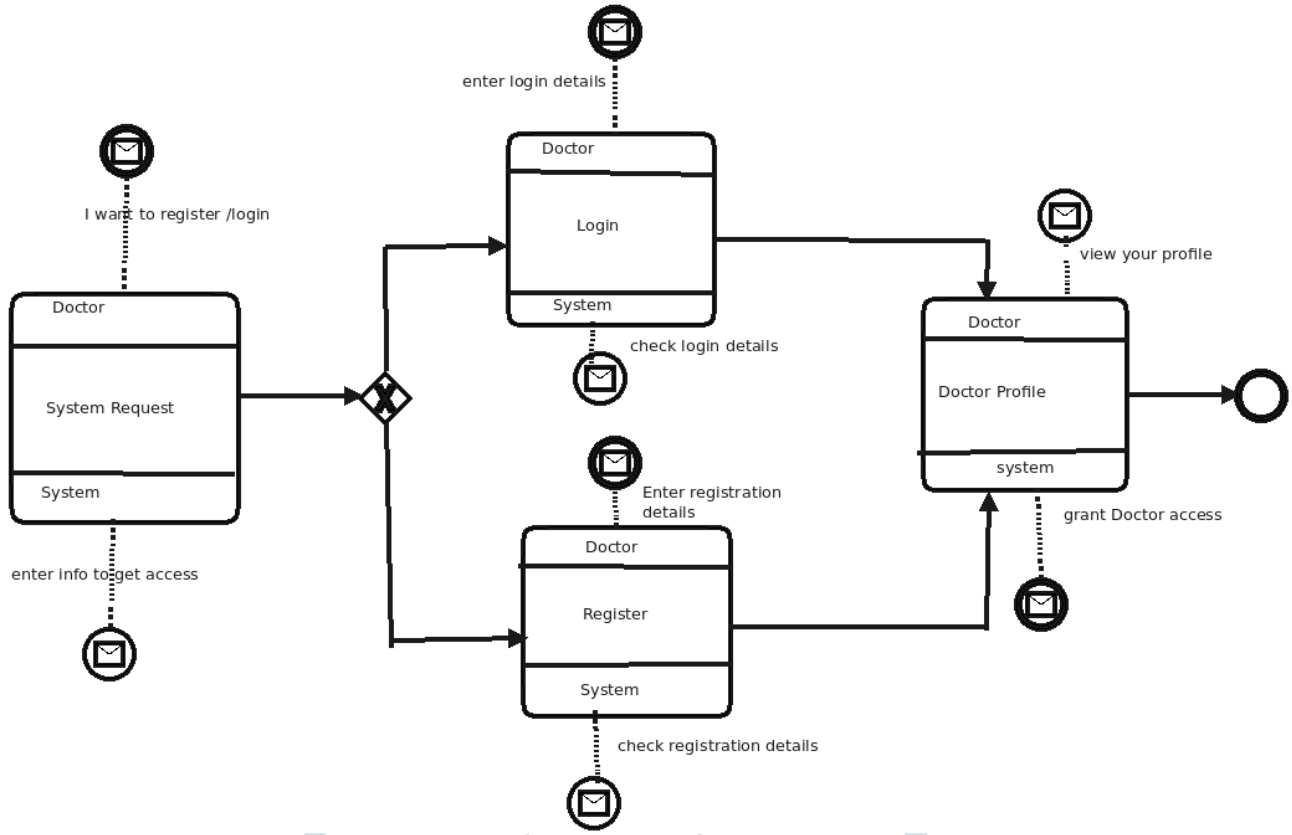


Figure 5: Collaboration between Doctor and system

System Analysis

System Requirement Analysis:

This includes the development environment and the operating system in which this telemedicine app is built for. The capacity of the client and servers and the type of processors required in the hardware to develop this application ranging from back end to front end.

Introduction:

A system requirements analysis is a complete description of the behavior of the system to be developed. It includes a set of use cases that describe all of the interactions that the users will have with the system. In addition to use cases, the system requirement analysis contains functional requirements, which define the internal workings of the system: that is, the calculations, technical details, data manipulation and processing, and other specific functionality that shows how the use cases are to be satisfied. It also contains nonfunctional requirements, which impose constraints on the design or implementation (such as performance requirements, quality standards or design constraints). System analysis workswith users to identify goals and build systems to achieve them. System analysis is animportant phase of any system development process. The system is studied to theminutest details and analyzed. The system analyst plays the role of an interrogator anddwells deep in to the working of the present system. In analysis, a detailed study of theseoperations performed by a system and their relationships within and outside of thesystem are done. A key question considered here is “what must be done to solve theproblem?”. One aspect of analysis is defining the boundaries of the system and determiningwhether or not the candidate system should be considered. The system is viewed as awhole and the inputs to the system are identified. The outputs from the system are tracedthrough the various processing that the input phases through in the organization. Duringanalysis, data are collected on available files, decision points, and transactions handled bythe present system. Once analysis is completed the analyst has a firm understanding ofwhat is to be done.

Existing System:

From research there have been such system before wherein the existing system it was noticed that patient and doctor can only do chat without video call functions Also the security of the existing system was not that guarantee because then, the doctor can was the key player in the system. Also, sending voice messages was not available in the existing system. Sending current location was also not available in the previous system.

In order for patients to request an appointment was not available. From Sierra Leone own perspective, there have not been any such platform before as this will be the very first telemedicine application accessible to the public. This is to reduce the long wait time in hospitals to meet a doctor. Hence using this app, one can even stay at work and

consult a medical doctor of choice.

Proposed System:

In this proposed system, a patient and doctor both need to register before getting accessinto the system. After they have registered for the first time, they need not register againfor the second time. A patient can thus create a profile and the upload a profile photo,after that, the patient can request a meet with the doctor by clicking on the contactDoctor button, which will then take the patient to the contact form where the patient candecide to either do a video call, chat or view location of an address. It also depends onthe doctor to either accept a book request from a patient or to cancel it. If the request is declined by the doctor, the patient can thus logout from the system or go back to thepatient profile.

- **Patient :**

  Here the patient has to first of all create a registration by providing his/her details and then after could be able to get access into the system. After registration, the patient is given access right into the Patient profile. Also, the patient upon registration, they can get access into the login form. Therefore, whenever they want to get access into the system, they need not register again.

- **Doctor:** The doctor process is just the same as the patient process, the doctor can also provide user email and password to register into the system, after that, the doctor can edit profile info from the Doctor profile activity. Jitsi is a collection of free and open-source multiplatform voice overIP (VoIP), video conferencing and instant messaging applications for the web platform. Jitsi is protected by the Tor project. It is 100 percent highly secured. It is encrypted, open source and you don't need an account. At the heart of jitsi are jitsi video bridge and jitsi meet, which let you have conferences on the internet, while other projects in the community enable other features such as audio, dial-in, recording and simulcasting.
- **Secret Code:**

  If you want to do video call or chat, as a patient all you need to do is to create your account with your credentials then you will have full access to the system, after which you can then login into the system generate a pin yourself which you will use later to share to a doctor to do video call or chat. The doctor can then use the pin provided by the patient to communicate with the patient.

Requirements Analysis and System Design

Introduction of Requirement Analysis:

Requirement is a complete description of the behavior of the system to be developed. Theseequirements include: functional and non-functional requirements. Requirement analysis task is aprocess of discovery, refinement, modeling and specification. Both the developers and customerstake an active role in requirement analysis. Requirement analysis is a communication intensiveactivity. Requirement analysis can be divided into:

- Problem Recognition
- Problem Evaluation and Synthesis

Problem Recognition:

The goal of this step is recognition of basic problem elements as indicated by the customer.

The basic purpose of this activity is to obtain a thorough understanding of the needs of the client and the user, wh a t exactly is desired from the software and what are the constraints on the solution. Problems of the existing system:

- Security can't assure
- Delay in storing and retrieving information
- Possibility of human errors.

Problem Evaluation and Synthesis:

In this step we analyze and define all externally observable objects, evaluate flow and control of the information, define and elaborate all software functions, understand software behavior and design constraints etc. Evaluation and synthesis continue until both analyst and customer are confident about the problem. Once the problems are identified, the evaluation process begins. After evaluation of the current problem and desired information, the analyst synthesizes one or more solutions.

- minimal chances of error
- easy to use
- cost effective
- security is guarantee

Functional Requirement:

A functional requirement defines the internal workings of the system: that is, the calculations, technical details, data manipulation and processing, and other specific functionality that shows how the use cases are too satisfied. The functionalities of the system or modules mean what the system is supposed to do.

For admin Module:

- This system allows the admin to allow new patient have account
- This allows the admin to add a new patient account.
- This system allows the admin to add a doctor's details.
- the admin can delete a user from the system
- The system allows the admin to view Doctors and Patients details.

- **For Doctor Module:**
- This system allows the doctor to register
- This system allows the doctor to login with password and username or email
- This system allows the doctor to accept or reject chat or call.
- This system allows the doctor to view patient details.
- This system allows the doctor to update personal information.
- This system allows the doctor to treat new patient.

System Design:

Introduction:

The system design is one of the most challenging and creative aspects of the system lifecycle in developing a system. When we talk of design , we mean the final proposedsystem and the processes involved in its final creation. It also means the technicalitiesinvolved while implementing the proposed system. It involves the making of theprogram structure and the designing of input, output, menus, codes, database creationand process of the system. System output might be reports, documents or messages. For this proposed system, which is an online application, information is displayed on thescreen. The layout sheet for displayed output is similar to the layout chart used fordesigning output. The designing of codes relies on the programming language chosenand mostly they are not specified while outlining the design of the system. The goal of coding is to translate the design of the system into code which the machine can understand and interpret it into a way human beings can understand. The aim of the code is to implement the system in the best possible manner. The Firebase database is used here to define and specify the structure of objects used inthe system. A wide array of design information must be developed during the databasedesign. A database is the collection of interrelated data stored with minimum redundancyto serve many users quickly and efficiently. The general objective of a database is to makeinformation access easy, quick, inexpensive, and flexible for the user.

Architectural Design:

Design Approach

This project has been done using Android studio with java and connected to firebasedatabase webserver as the backend to save users credentials. Also, Jitsi web server is usedfor video calling and chat. Jitsi has some inbuilt functions which makes it well securedand easy to use.

The Developing System:

The system has developed in ANDROID STUDIO WITH JAVA as front end andfirebase database to save users information as back end. also involves Jitsi web server toenable video conferencing.

Tools and Platform Used

Operating System: Android studio Database used: Firebase database ProgrammingLanguage used: Java Web Server: Jitsi web server

Introduction To Android Studio

Android studio is a mobile app developed by Google to mirror features from an Androiddevice, such as a smartphone, to a car's compatible in-dash information andentertainment head unit. Supported apps include GPS mapping/navigation, musicplayback, SMS, telephone, and web search. The system supports both touchscreen andbutton-controlled head unit displays, although hands-free operation through voicecommands is encouraged to minimize driving distraction.

Firebase:

Is a NOSQL, hosted database that uses data synchronization to automatically receivenew Information in real time from every connected client, without requiring you to setup your own application server.

Google Pay

Google pay also known as G pay or Android pay is a digital wallet platform and onlinepayment system developed by Google to power in-app, online, and in-person contactlesspurchases on mobile devices, enabling users to make payments with Android phones, tablets,or watches.

It works by opening a google pay account and connecting it to your bank account.

Users can make payment by entering the amount they want to send to another personand also inputting their UPI code, this UPI is your account number which will beprovided to you when you want to make payment.

Jitsi

Jitsi is a collection of free and open source multiplatform voice overIP(VoIP), videoconferencing and instant messaging applications for the web platform. Jitsi is protected bythe Tor projects. It is highly secured. It is encrypted, open source and you don't need anaccount. At the heart of jitsi are jitsi video bridge and jitsi meet, which let you haveconferences on the internet, while other projects in the community enable other featuressuch as audio, dial-in, recording and simulcasting.

Features of Jitsi:

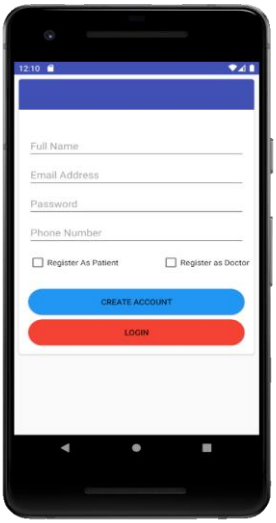
- Jitsi videobridge passes everyones video and audio to all participants rather than mixing the first.
- Better quality, lower latency and if you are running your own service, a much more scalable and inexpensive solution.
- Jitsi is compatible with WebRTC, the open standard for web communication.
- Advance video routing support for simulcast, bandwidth simulations, scalable video coding and many others.

Structure of the Application:

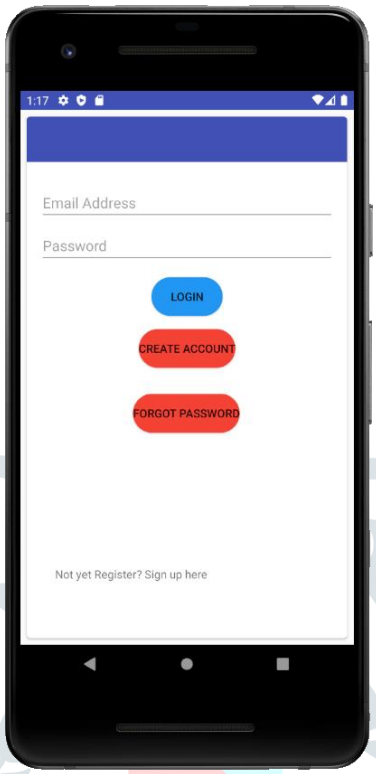
- activity location
- Book doctor
- payment gateway
- newLogin
- Forgot Password
- New registration
- video call
- Client profile
- Consultant profile
- dashboard screen
- splash screen

Below are samples for some key activities:

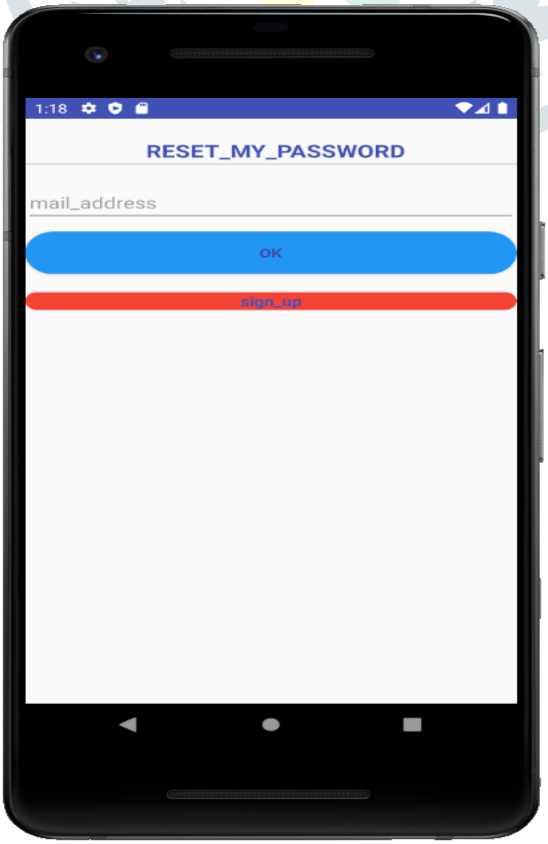
- **New Registration:** Here you have to either register as a patient or a doctor. You will be required to provide your full name, email address, password and phone number. then check the checkbox for either a patient or a doctor and click on create accounts. You are required to fill all the required fields other than that you would not be able to register or create an account. After creating an account, you will be sent to either the patient profile or doctor profile.



- **New Login** After your complete registration, here is the login screen that you will be using to login into your created account. You can only login after your complete registration. When you have registered, your information will be saved into our database. In the login screen also, there is a provision down which allows you to go back to the registration interface in case you have not yet registered.



- **Forgot Password** If the user, after creating an account, forgot their password, they are able to reset their password through this forgotten password screen. They will be redirected to their email address in order to try a new password.



- **Patient Profile:** In the patient profile, the patient is required to create his/her

profile after logging in and enter the following details, name, address, country, blood group, complaint about his/ her illness. then those details will be saved and whenever he/she logs in, that information will be still there.

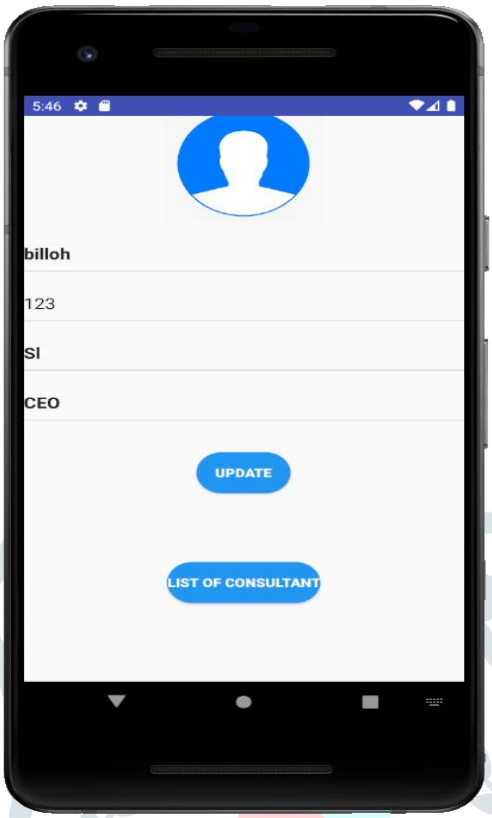


Figure 9: Patient Profile

Also, the patient is allowed to upload profile pic which he/she can change at any time. after filling this information, the patient can then click on view doctors which will then take the patient to the doctor profile, he can then choose which doctor to contact based on their qualification and country of origin.

- **Doctor Profile:** The doctor profile, like the patient profile, upon successful login or registration, he /she can enter credentials like name, address, qualifications and country. And then save those credentials.

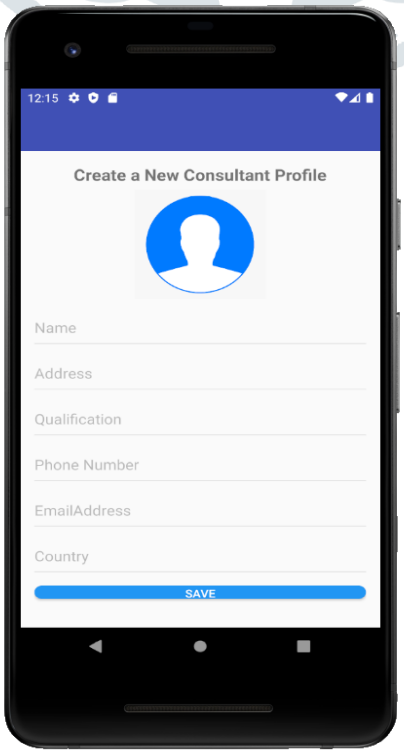
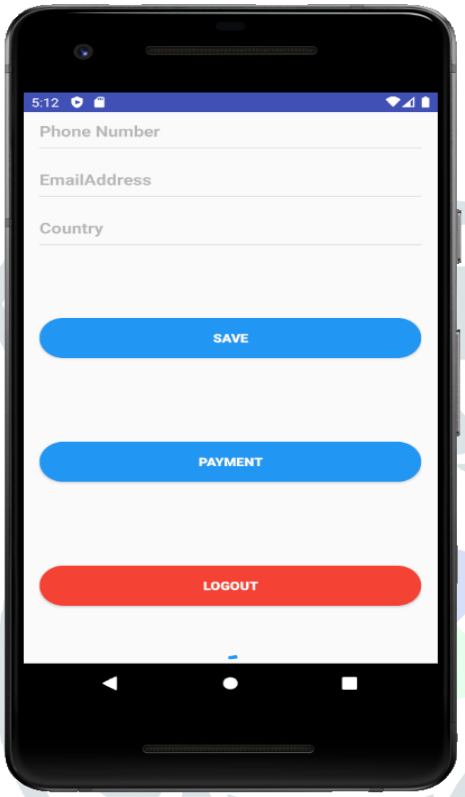
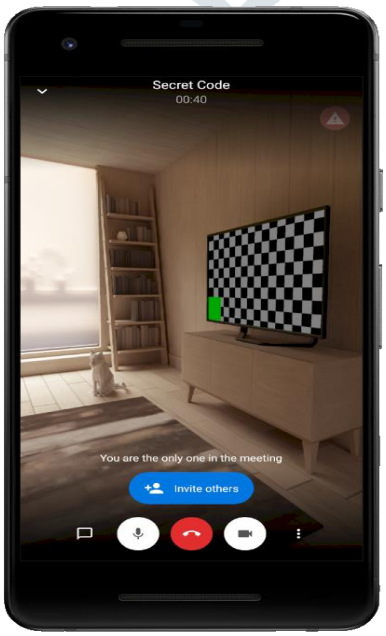


Figure 10: Doctor profile

The doctor can also upload a profile pic and can change it whenever he/she feels. Also, in the doctor profile there is a button for payment and logout. It is that payment button the patient can use to pay for the consultation services to the doctor. For now, the payment gateway that is available is google pay.



Video call: The video call functionality is supported by jitsi. Jitsi webRtc server enables one to use their server to do video calls and chat for free.



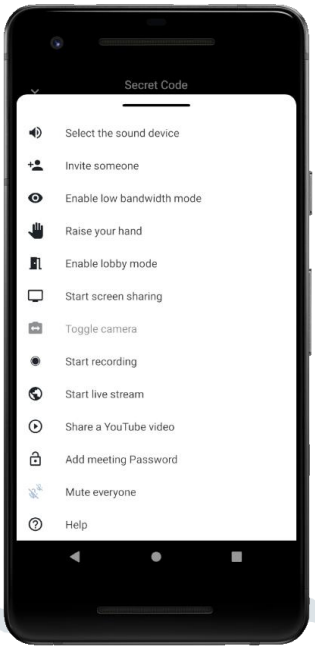


Figure 11 Video call and features

- Chat: The jitsi chat functionality is supported by jitsi. Jitsi webRtc server enables one to use their server to chat for free with one another.

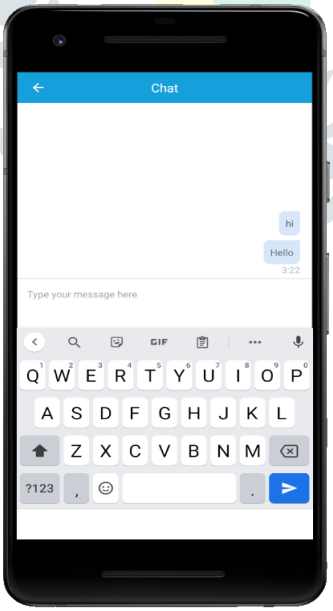


Figure 12: Chat

- **Payment activity:** The payment gateway is supported by google pay for now, other payment gateway will be added subsequently as we progress. The fields, username, UPI code also known as the code to which you are sending the payment, amount and test of payment. After that you need to click on the payment button. After successful payment, you can then click on the Book doctor button that will take you to the video call interface.

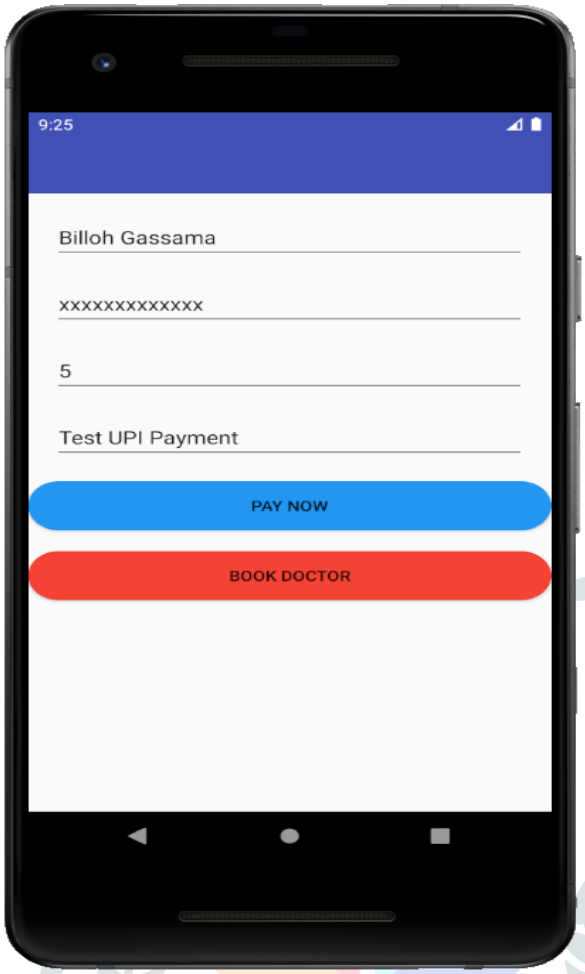


Figure 13: payments activity screen

Result ,Summary and Discussion

This system has been tested for basic functionality. It can run on android platforms with minimal space. It was proven to be workable. In order to use the system, one needs to first of all register with their credentials and then registration can be done. It is recommended that one needs to have prior knowledge about installing an android device from the play store before using the app. Also, for a client in order to book consultants appointments, one can pay for the service either before meeting or after meeting, hence one needs to have virtual cash in their account.

Furthermore, a data collection process was done on 10 participants to know the views of end users prior to the completion of this system. According to the survey, 70% of the respondents were male whilst 30% were female. Also, 60% of the respondents were students

whilst 40% were workers from different fields.

When asked if anyone has ever used a teleconsultant app before, the response was from figure 22, 70% said they have never used it before whilst 30% said yes, they have used

it. Furthermore, figure 23 shows that 75 % said it was average whilst 25% said it was good. Also, from the survey, that is from figure 24, the respondents were asked if they have ever visited a doctor during the pandemic and the it shows a 50% balance for both those that have visited a doctor or a teacher to those that have never visited before. Also, when asked what was the mode of consulting, figure 25 shows that 66.7% of the population said in person whilst 16.7% and 16.7% said no. From the respondent questionnaire, when asked what is the mode of meeting a teacher or doctor, figure 26 shows that 50% said offline, 10% said face to face, 10% also said they have not met a doctor or teacher whilst 30% said online.

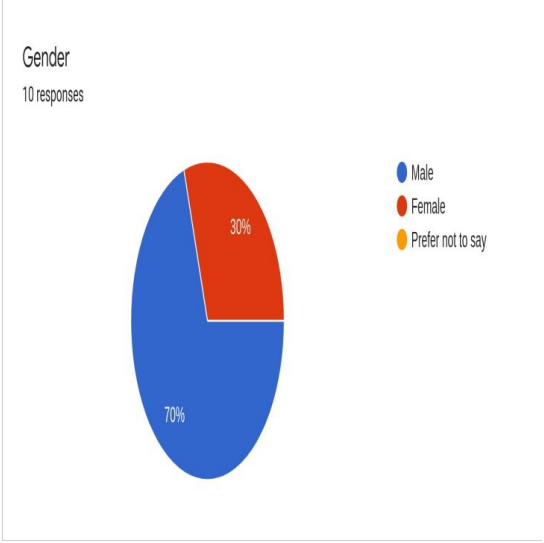


Figure 14: gender

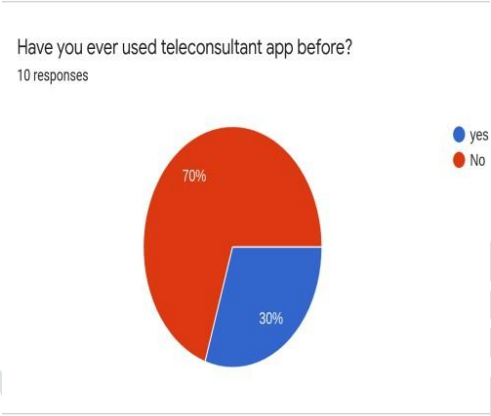


Figure 15: when asked if user had ever use similar app

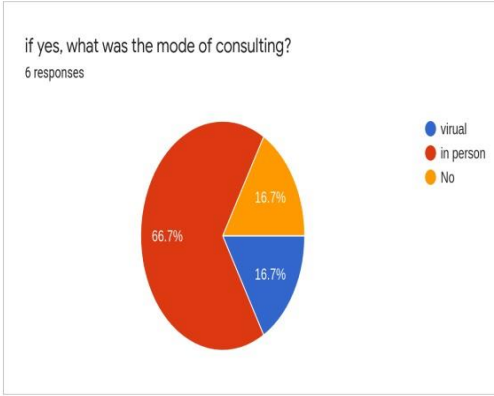


Figure 16: Response to figure 15

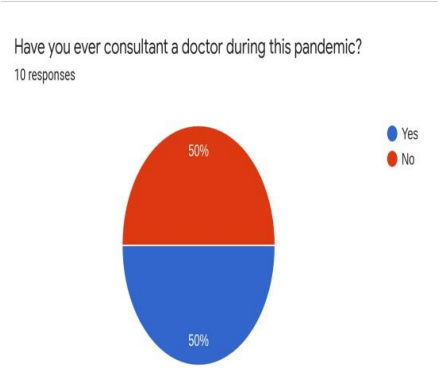


Figure 17: when asked if ever made any consult with a doctor

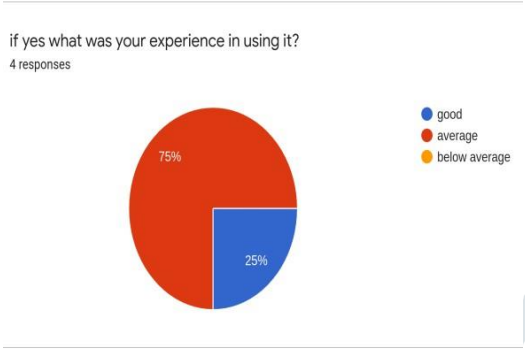


Figure 18: Response to figure 17

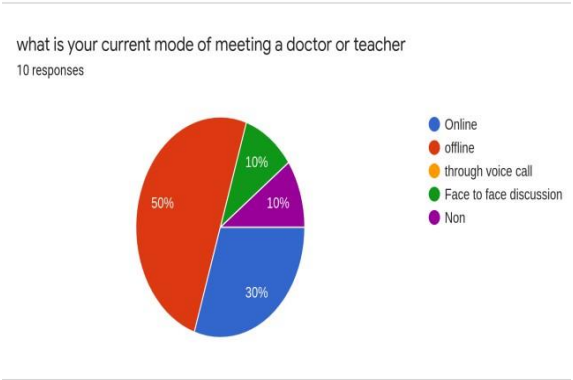


Figure 19: what is the current mode of meeting a patient or a teacher?

Conclusion and Future Work

With regards to the future works and limitations, I have categorically mentioned some of the challenges encountered during this project which are viz: In relation to doctors, information being saved in the applications have not been included. Also, we need totake into consideration robust security mechanisms about the system to make it more secure and to avoid third parties to fraud the system. Furthermore, in future work we would integrate how clients can rate consultants/doctors as per their effective and

efficient delivery of services. Also, another function to be added in future work is the saving of users' records so that they are able to know their past records before consulting a consultant. The following list depicts the functions to be added in future

work:

- To show the number of patients treated by a doctor.
- To give doctors review by a patient via the star rating method.
- To enable safe recommendations made by a doctor.
- To add AI features in the system.
- To make the system more user friendly.
- To mitigate bugs encountered during the implementation of the system.

Also, with regards to testing, only one side user was used to test the efficiency of the system, therefore, in future multiple users will be tested to see how best the system can perform. In conclusion, further research on the topic could focus more on looking out for bugs, adding AI functions which will make the application more robust and learn from itself by adding machine learning functionalities. The importance of teleconsultant cannot be fully overemphasized as we all know how significant this application is. If as already discussed all goes well, this app will serve as a panacea to salvage the current situation we are facing where communication is a problem using virtual communications. Also, on further research, this app will be to make it more robust and useful. On a successful completion and implementation of this project, users (clients/consultants) can be well assured that their information is well protected because the client has total control over their record.

After the recommendation the patient can opt to pay for the service rendered. It will also help locate the nearest health center using google map to determine health centers in close proximity. It will also help to track the location of the doctor or healthcare worker.

There is also a plan B of this project where Artificial intelligence functions can be included, which is to say chatbots will help to speak to the patient in case a medical worker is not available by giving some health advice tips to the patient. The platform can also do a pre-test on patients towards a particular complaint given by the patient. Also, this platform helps to improve the communication between a doctor and a patient as explained in an example which we already took, but it is not limited to doctors and patients only. This app helps to democratize the health situation by giving the level playing field for every one using the app by giving access to doctors. It also helps to reduce the more paperwork done by doctors, and there can be monetary benefits in using this application for instance, patients can pay for a service if accurately given the right prescription. I strongly believe that those challenges are not limited, and some of them can be overcome in the next version of the app as anything cannot be concluded in a single step. The project entitled "Modelling and Implementation of a TeleConsultant Application" was successfully designed, developed and tested. The system and the architecture is a compatible one. So, addition of new modules can be done without much difficulty. Since this module has its unique properties, it can extend further to make this system a complete one.

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