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A Mobile phone solution for systematically identifying and reporting unqualified practitioners in healthcare, Kenya

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A Mobile Phone Solution for Systematically Identifying and Reporting Unqualified Practitioners in Healthcare, Kenya.

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Submitted in partial fulfilment of the requirements of the Degree of Masters of Science in Mobile Telecommunication and Innovation.

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Declaration and Approval

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

Aradi Doreen Viduya

.....D.A.V.....

.....6th June 2017.....

Approval

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Dedication

I dedicate this work to the Almighty God who gave me the favour and opportunity to do this masters, Safaricom and @iLabAfrica for the opportunity, support and training they offered for the attainment of this masters.

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Finally, to my family, friends and colleagues who assisted when I was in need, I give heartfelt regard and gratitude

Thank you all!

List of Acronyms/Abbreviations

API	-	Application Programming Interface
KIPPRA	-	Kenya Institute for Public Policy Research Analysis
KNBS	-	Kenya National Bureau of Statistics
KMPDU	-	Kenya Medical Practitioner and Dentist Board
WHO	-	World Health Organisation
TMP	-	Traditional Medical Practitioner
UML	-	Unified Modelling Language

Abstract

Effective observation and reporting of unqualified health practice demands timely identification and dissemination of information to bodies responsible for licensing, regulation and certification of health care practitioners to warrant necessary action in case of any malpractices. Tools used to identify and report existence of unqualified practitioners and unregulated health facility determine the level of efficiency and effectiveness of the exercise. Traditional way of reporting incidences of unqualified practitioners through the media and crack downs done by the Medical Board reporting procedures compromise on completeness, timeliness and correctness of information. This scenario creates unprecedented opportunities whereby the researcher can use to improve the current way of identifying and reporting unqualified practice in health care. A mobile application was developed to offer an interactive menu where users search for qualified practitioners and report unlicensed doctors and health facilities on their mobile devices. Agile methodology was adopted as the software methodology for developing the application.

Tru-Daktari, a mobile application was developed as a tool to offer an interactive menu where users can search for health practitioners and registered health clinics and report unregistered health practitioners through the application installed on their mobile phones. The proposed solution was developed on Android platform. It was developed concurrently with a web application developed in PHP. The testing of the application was successful and it was strongly agreed by the respondents that the system would be effective in solving the existing problem. The recommendations made by users were used to improve the application. Based on the overall statistics of user testing and evaluation it is safe to say that the application fulfils its usability and functionality requirement. Based on the questionnaire responses, the application is generally considered easy to use and understand. The implication of the results of application testing is that the application will come in handy in reporting unqualified practice in health care thus leading to quality health care.

Keywords: **unqualified health practitioners, unlicensed health facilities, licensing, Tru-Daktari,**

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Chapter 1: Introduction

1.1 Background of the Study

The professionalisation of medicine allows for medical providers to better meet their ethical mandate to provide the highest quality of care possible. Education and licensing standards are set to assure that unqualified practitioners would not be permitted to practice medicine. The professionalisation of medicine has specifically target the three components of high quality health care by defining who should be qualified to practice medicine, connecting medicine to the developments of science, and developing a medical infrastructure (Martineau, 2014). Health practitioners and health facilities are registered and licensed by the Kenya Medical Practitioners and Dentists Board (KIPPRA, 2004).

According to Deloitte Economic Outlook Report Kenya only has one doctor for every ten thousand patients with 50% of the doctors practicing in Nairobi, which caters to a small proportion of the population, a number way below the World Health Organisation (WHO) recommendation for ten for every ten thousands patients (Deloitte, 2016). A large proportion of Kenya's health providers are unlicensed and some of these informal providers possess training in a health or pharmacy-related field but not enough to qualify for licensure under the Medical Board, while others operator wholly untrained (World Bank, 2008).

Despite the existence of the Kenya Medical Practitioners and Dentists Board, there is a feeling among most regulated professionals that quacks and unqualified health professionals continue to practice privately in the country, despite some well-known crackdowns by the medical board (World Bank, 2011). In some cases, training schools unapproved by the responsible board start courses that do not qualify a graduate for registration. In other cases, individuals assume the title of nurse or doctor without registration, and escape punishment (World Bank, 2010).

Cases of people impersonating as fake doctors is not new to Kenyans. Money hungry individuals infiltrate the sector, risking the lives of millions (Arende, 2016). Quacks have found health products and services to be perfect avenues to maximising their monetary gains with minimal efforts. Patients have a strong desire to live and when disturbed with sickness that do not seem to heal fast they are easily convinced by quacks. They are so vulnerable to promises of health improvement and lifesaving solutions (Wasike & Tenya, 2013).

One can find their advertisements, signboards and offices of quacks in every town. They have neither a recognised degree nor a license to practice medicine and yet a number of quacks are running their dispensaries in every part of the country. They even put up signboards in front of their dispensaries, claiming to be specialised doctors and even handout prescriptions on their letterheads (Gupta, 2010).

According to In Harm's Way Report (2012) it states that quacks are still a big problem. The private practice is not very well-regulated so anyone without much training can pretend to offer services. One can get a license from a doctor and just open a clinic and be a quack and not trained at all. This happens quite often in Nairobi especially in the slums region. Citizens are unable to distinguish between qualified and unqualified providers, women unknowingly obtain services from unqualified individuals. The instruments used by these unqualified providers are not clean or sterilised and they are not able to examine the patient correctly and as a results they end up rupturing the woman uterus. Unqualified health practitioners can be identified only when they are caught and the clinic is closed (Centre for Reproductive Rights, 2010).

Currently Kenya has no reporting platform for unqualified practice in the health care. The unqualified practitioners and unlicensed clinics can be identified only when a patient is harmed due to this malpractice, while unlicensed clinics are identified only when there is crack down done by the medical board. Therefore there is need to have a systematic way to identify and report unqualified practice in health care within Kenya.

1.2 Problem Statement

A significant number of Kenyans have the stereotype that everyone dressed in a white coat in a hospital setting is a qualified doctor, an ignorance which has costed some dearly (Oluga, 2015). Statistics by the Kenya Medical Practitioners, Pharmacists and Dentists Union indicate that 90 per cent of Kenya's clinics are run by unqualified people (KMPPDU, 2015).

There exists a significant gap in disseminating information on registered practitioners. Currently information on registered medical practitioners and licensed health facilities can only be obtained from the KMPDU website portal which supports only limited user interaction in acquiring adequate information. Some users also complain that the site does not offer convenience and reliability to acquire data as needed and also does not provide a platform to report incidences of misconduct and quacks. As a result of this gap and challenges in acquiring the information, a significant number of Kenyans have suffered as a result of quack medical practitioners and malpractices. Some have been molested, paralysed and even others killed.

1.3 Research Objectives

i. To understand the challenges faced by patients while identifying qualified practitioner and licensed health facilities.

ii. To review related architecture, models and application used in verification of doctors and health facilities.

iii. To develop, design and test a mobile based solution for identifying and reporting unqualified health practitioners.

iv. To validate the developed application.

1.4 Research Questions

i. What challenges do patients face when identifying qualified practitioners and licensed health facilities?

ii. What are the existing architecture, models and application used in verifying health practitioners?

iii. How can the mobile application be used in verifying health practitioners?

iv. Can the developed application assist in identifying and reporting unqualified practitioners?

1.5 Scope and Limitations

For purposes of creating a model mobile application, the case study will be conducted in Nairobi, Kenya. Attention of this research will be limited to patients who visit clinics in Nairobi area this is because slums in Nairobi is the most affected area with quacks and unlicensed clinics. The developed application was implement on the Android Operating System as the underlying software platform targeting users with access to data enabled mobile devices.

1.6 Significance of the Study

The Government's vision for the health of its citizens in its economic blueprint Vision 2030 is to provide equitable and affordable health care at the highest affordable standard. In order to achieve this, the Vision recognises that a functional health system has to be put in place. Such a system should increase access to quality health facilities and qualified health practitioners, as a result it will improve health outcomes.

Development of a mobile based application may not address all the issues surrounding the provision of quality health care but it at least removes from the equation the hopelessness and helplessness that citizens feel when it comes to confirming the authenticity of their health care providers. The mobile application will be used by Kenya Medical Practioners and Dentistry Board, patients and the general public within Nairobi County in Kenya. The solution is scalable and can be customised and replicated to other parts of the country.

1.7 Conclusions

The chapter has discussed the background of the research highlighting the existing problem of unqualified practitioners and unlicensed health clinics. The research aims at developing a mobile application to address the research objectives and respond to the research question. The next chapter, is the literature review.

Chapter 2: Literature Review

2.1 Introduction

This chapter explores the literature review of similar systems used to report health incidents. It also focuses on their structure and architecture as well as their implementation. The study has also been supported by a few of theories and how it has been reviewed by different authors. In Kenya there exists weak punitive legislations, corruption is all over and it has also become apparent that medical practitioners no longer observe ethics and integrity. These are the factors that continue to inform the infiltration of rogue health practitioners in the country. The health sector in Kenya is iffier serious attack from rogue undeserving health care personnel due to the demands of health service and poverty (Opany, 2015).

2.2 Theoretical Literature

This research uses the theoretical framework of professionalisation to analyse the professional system. This research is supported by two theories namely, the concepts of Traits and Control. The Traits Theory involves some traits that are required to enhance occupations to professions. The concept of Control is applied to examine an occupations relation to the labour market.

2.2.1 Theory of Control

The Concept of Control examines an occupations relation to the labour market and other institutions in society. The more control members of an occupation have on their work and on the market in which they practice, the more professionalised the occupation. Hence, professions are viewed based on the power they have collectively rather than individually. This power can be used to exert control on the body of knowledge, training, and code of ethics for practitioners, working conditions and on how they relate to clients. A profession gains power and controls the market by demonstrating their expertise, hence blocking unqualified practitioners from practicing (Mikkelson 1996).

2.2.2 The Trait Theory

According to the Trait Theory, an occupation advances to become a profession by attaining some characteristics. These characteristics include skills and knowledge, formal registration of the occupation loyalty among colleagues and codes of ethics. The more the characteristics are achieved the more an occupation becomes professionalised (Witter & Johnson 2004).

2.3 Empirical Literature

The concept of Control Theory is stated by several other professional theorists. Larson (1977) sees professionalisation as the process by which producers of special services sought to constitute and control a market for their expertise. The concept is also reviewed by in Abbot (1988). According to him, there are various aspects that determine how much control an occupation has such as the control over tasks as defined in the profession's cultural work, in the legal discourse and in workplace negotiation. The control reflects the social structures of the profession and creates stability in the process of competition. Freidson (1994) sees professions as groups aiming to dominate and control their work

by using their expertise in order to avoid subordination. According to him, the control over work builds a foundation of a dominant position within occupations. This control is gained by achieving skills and knowledge which is important to get established in the labour market. The next step in gaining control is setting standards of the Profession and the formation of professional organisation (Freidson, 1994).

The concept of Trait Theory by Houle (1980) states some traits that are required to enhance occupations to professions. According to him for an occupation to professionalise, the occupations defining functions need to be clarified. In addition the members have to seek self-enhancement to improve performance by incorporating theoretical knowledge, use practical knowledge and have a capacity to solve Problems. Having formal training and attaining credentials creates a culture of collective identity. This ensures legal reinforcement where incompetence is not tolerated and ethical violations are penalized. As a result an occupation gains public acceptance and builds relations to other occupations and service users. Practitioners of an occupation should also always seek new knowledge even in areas that are not directly related to their jobs (Houle, 1980). Witter (2004) suggests that traits are stable in established professions, that they are evidenced across professions, and that there are individual differences in the strengths and number of traits in each profession. A code of ethics refers to the public statement regarding the service mission of the profession. It relates to the protection of consumers rights, their privacy and confidentiality (Witter & Merithew 2004).

2.4 Challenges Faced by Patients Due to Unqualified Health Practice

The main threats to patient safety worldwide are inadequate numbers of equitably distributed, qualified health-care providers and incomplete knowledge about safe practice (WHO, 2008). Unlicensed and unqualified practitioners pose a risk to the public and to the integrity and future of the profession (Hammond & Kirk, 2008).

Research by APHRC (2010) in informal settlements (slums) in Nairobi, Kenya, has shown that these areas have a maternal mortality of 706 deaths per 100,000 live births, which is higher than the country's average 560 per 100,000 live births. The research has further revealed that nearly half of expectant women in slums deliver either at home, with the unlicensed and unregulated health facilities that lack capacity to handle even minor obstetric complications (Oronje, 2009).

Unsafe abortions have devastating effects on women's health. While some abortions are self-induced, most of the abortions are frequently performed by providers lacking qualifications and skills to perform induced abortion and hence termed unsafe. Although unsafe abortions are preventable, they continue to pose undue risks to a woman's health and may endanger her life. WHO defines unsafe abortion as a procedure for terminating an unintended pregnancy carried out either by persons lacking the necessary skills or in an environment that does not conform to minimal medical standards, or both (WHO, 2008).

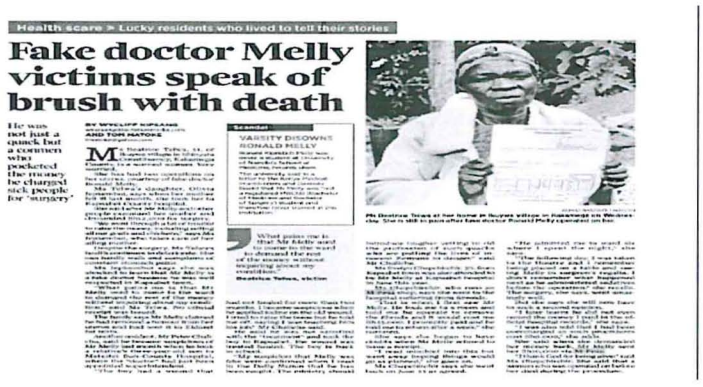
In Australian aged care facilities registered nurses are increasingly being substituted by unqualified and unlicensed health care workers, who are less expensive to employ, leading to a lower level of safety and quality of care and putting these vulnerable patients at risk. The aged care accreditation data on failed standards reveals that this has led to a decline in quality of care with residents exposed to serious risk from neglect, poor infection control, malnutrition and dehydration and assault (Armstrong, 2009).

2.4.1 Reported Cases of Victims in the Hands of Unqualified Practitioners

Pakistan- In 2014 September, a pregnant woman died after a quack administered her a wrong injection in a private clinic in the Hunjarwal area on Friday. A pregnant woman had been taken to maternity clinic on Multan road, Hunjarwal, where the doctor administered her a wrong injection, resulting in her death. The doctor disappeared after the incident (Pakistan Telegraph, 2014).

India - In 2016 June, A 45 year's old male patient was presented stage of respiratory failure with lock jaw in tertiary care hospital in Peripheral Maharashtra. He was treated by ointment by local quack and 10 days before he was undergone surgery by the same quack. After eight days of surgery the patient suffered problem in opening the jaw and tonic contraction of the body, difficulty in defecation, urination and breathing (Mukhopadhyay, 2016).

Kenya – In 2016 November, Beatrice Telwa 51 year old from Ikuywa village in Shinyalu constituency, Kakamega County. She has had two operations on her uterus, performed by fake doctor Ronald Melly. Despite the surgery, Ms Telwa's health continued to deteriorate. She can hardly walk and complain of constant stomach pains (Daily Nation, 2016).



Health scare > Lucky residents who lived to tell their stories

Fake doctor Melly victims speak of brush with death

He was not just a quack but a conmen who pocketed the money he charged sick people for "surgery"

Figure 2. 1 Victim Speaks of Brush with Death (Daily Nation, 2016)

2.5 Factors That Contribute To the Thrive of Unregulated Practitioners and Facilities in Kenya

The private healthcare sector contribute significantly to delivery of healthcare. Private clinics, pharmacies, nursing homes and traditional practitioners have come up in most urban and rural areas. However, they have operated in an unregulated environment, sometimes with unqualified personnel

and in unlicensed facilities. Lack of resources by the regulatory bodies and those they are expected to regulate are to be blamed on improper regulation (KIPPRA, 2016).

Regulatory bodies and councils are less disturbed in enforcing laws, guidelines and standards that govern the quality of healthcare services in this country for various disciplines. The bodies and councils play a minimal role in regulating the quality of healthcare services and facilities in the country. On several occasions, Kenyans learn through the media and other sources of many reported complaints which have attracted little or no action. The bodies have a tendency to protect and defend medical practitioners instead of addressing issues to streamline the quality of healthcare services (Transparency International Kenya, 2011).

In nearly all informal settlements in urban areas in Kenya, there are no public facilities, including health care facilities. This void has resulted in many private providers setting up poor quality healthcare facilities lacking qualified personnel, equipment and supplies to offer services to people living in these settlements. The private healthcare providers located within the slums are not regulated by the government and many are illegal as they are not licensed (Oronje, 2009).

Traditional medicine practice is not currently regulated by the government. Currently, TMPs need only to register with the Ministry of Culture in order to be recognised. However, there is still no legislation regulating traditional medicine as a result, among other problems, there are a large number of unqualified people pretending to be TMP practicing in the city, a lack of educational standards, no umbrella self-governing organization (Dahodwala, 2006).

Doctor's union say quack practitioners thrive due to tribalism. Deep rooted tribalism may have provided a fertile ground for unqualified practitioner to practice medicine. Outsiders doctors posted to the region were rejected and replaced with locals. Rejecting professionalism for ethnicity has put the country is putting the citizens live at risk (Oluga, 2016).


Quack > Nurses rejected him as he would give wrong doses, risk patients' lives

Doctor's union says quack thrived due to tribalism

Medics union says 'foreign' doctors shunned in favour of locals

BY EUNICE KILONZO

"They rejected the professionals only to hire quacks as we have seen"
Dr Ouma Oluga, KMPDU secretary-general

Maternity unit

Figure 2. 2 Doctors Union Speak about Quack in Kenya (Daily Nation, 2016).

Kenya's acute doctor shortage creates an ample opening for quacks to operate. With only a few doctors to serve a population of 44 million, is the reason that some people who see this as a chance to

self-enrichment. Many public health care facilities are far from home, congested, ill-equipped and sometimes lacking medicines. Sick Kenyans are forced to turn to the person nearest to whom claims to be knowledgeable, sometimes with deadly results (Gicheru, 2016).Figure (2.3) below show the registered number of medical personnel.

Table 12: Number of Registered Medical Personnel, 2010 -2013

Numbers

	2010	2011	2012	2013*
Doctors	7,129	7,549	8,092	8,682
Dentists	898	930	985	1,045
Pharmacists	2,337	2,432	2,076	2,202
Registered nurses	29,678	31,719	35,148	37,907

Figure 2. 3 Number of Registered Medical Personnel in Kenya (KNBS, 2015).

2.6 Challenges Facing Developing Nations Due to Unqualified Practitioners

Due to India's huge population and growing economy, the demand for health care is rising rapidly, and the existing number of registered professionals is inadequate to deal with this increased demand. This is leading to the spread of quackery, which is one of the most serious challenges facing the medical regulatory system in India (RAND EUROPE, 2009). In Delhi there are around 40,000 people living in the crowded slums where up to a third of the capital's population of 14 million live that seeks medical attention from an unqualified practitioner who runs a dingy clinic shacks, which contains a stethoscope, a thermometer and a big pile of pills (The Economist Newspaper Limited, 2008).

Every year thousands of people either lose their lives or suffer significant harm at the hands of quacks in Pakistan. Unfortunately, there are no reliable data sources and official figures on the number of people affected annually. Quackery is not only leading to avoidable deaths, it is also one of the leading causes of increasing morbidities in Pakistan (Ulhaq, 2016).

In Kenya as doctors and nurses move from rural areas to the city, they increase the workloads of colleagues they leave behind. These remaining workers end up overburdened and lack motivation, which means they cannot give quality attention to their patients the net result is a deterioration of health services. For example, there are only two doctors remaining in the Wajir district hospital who serve a population of about 200,000, whereas about 12 doctors are actually needed the average is six doctors per 100,000 populations. Unqualified personnel are also left to perform duties that are beyond their scope of practice, which puts the lives of patients at risk. For example, nurses have to perform the functions of medical doctors when doctors are absent (Mwaniki & Dulo, 2008).

The shortage of health professionals in Zimbabwe is mostly critical in rural areas where most health centers are being served by unqualified health staff. The decline in the number of skilled health professionals in the public sector has resulted in significant changes in the quality of care provided. Marginal and disadvantaged areas, such as rural districts, have been worst affected because the skilled

workers tend to shun such places. In addition, the nurse to patient ratio has increased, making it necessary for cadres who are not professionally qualified to attend to patients. Thus, the quality of care rendered has subsequently been compromised (Chikanda, 2004).

2.6.1 Documented Cases of Unqualified Practioners

Kenya –In 2015 September, Job Ratemo was arrested immediately after admitting to the board that he had faked papers to get a practising certificate which has been operating for five years (Nzioki, 2015).

Cambodia – In 2015 December, fake practitioner whom villagers considered a doctor infected 270 with reused syringes, killing 10 villagers (Aljazeera America, 2015).

Kenya – In 2016, 24 November, Ronald Melly a quack doctor was arrested by the Kenya police for practicing medicine in Mteitei sub-county in Nandi County without qualification and possible forgery of documents (Kipsang, 2016).

2.7 Challenges Faced By the Regulatory Bodies in Regulating Practitioners and Facilities

This section gives an overview of challenges faced by regulatory bodies, in this case, The Kenya Medical Practioners and Dentistry Board and how they cope with the problem of unqualified practice in health care.

2.7.1 Weaknesses in the Law and Regulations

In most of the developing world, the laws are better than the enforcement process, any regulatory assessment must look at how the laws are actually enforced. Several regulatory weaknesses affect both healthcare providers and their patients in Africa (Feeley, O'Hanlon, Stene, & Segzin, 2009). Boards exist yet quacks still reign, all over the place harming Kenyans (Daily Nation, 2015).

The laws and regulations governing private healthcare provision in Kenya have gaps that could compromise the quality of services provided in some private facilities. For instance, there has been a rapid increase in the number of private laboratory facilities operated out of doctors 'offices. Although doctors are required to register their laboratory facilities separately, and there are minimum qualifications stipulated for those who work in private laboratories, there has been little enforcement of this requirement (KIPPRA, 2004).

The recognition of traditional health practitioners through the African Customary Law creates conflict with modern law in terms of regulation of their activities. For instance, under modern law, medical doctors are not allowed to advertise their services. However, traditional health practitioners do it with impunity. This impartiality in application of law is not healthy for the patients especially given the misrepresentation of traditional practitioners as 'doctors'.

The Medical Board is only empowered to oversee the training of medical practitioners only in Kenya's universities, and this does not include continuous medical education. Medical knowledge of

most practitioners may not be up-to-date due to lack of a legal requirement for continuous updating of medical knowledge and skills. With the challenge of emerging new diseases, a practitioner may easily become limited in application of new methods of diagnosis and treatment and continue using outdated medical technology, leading to errors.

Health laws do not seem to be designed to protect the patient from negligent doctors or those whose skills have withered. Although malpractices such as caesarean births designed to charge a patient more money, poor surgical operations resulting to complications or death, wrong prescriptions, etc. are regularly reported, the Medical Practitioners and Dentists Board has not taken necessary disciplinary measures in most cases.

2.7.2 Efforts Made By KMPDB in Eradiating Unqualified Practice in Kenya

The Kenya Medical Practitioners and Dentists Board has banned medical camps hosted by foreign doctors. The boards seeks to protect Kenyans from some of the foreign doctors who do not have licenses to practice in the country or use the camps as hunting grounds for patients. People without a license cannot treat patients anywhere in the world therefore it is necessary for policy to be put in place for medical camps to practice with a license (Magoha, 2016).

The Kenya Medical Practioners and Dentists Board has embarked on mandatory registration of medical laboratories in all government and private health facilities as a way of wiping out fake ones. The Kenya Medical Practioners and Dentists Board have been carrying out the operations in a bid to close down those clinics and chemists that have not been registered (KMPDU, 2014). The Board has also been pursing cases of illegal practicing and misrepresentation. This is documented past press reports and the annual newsletters of the board. For instance, in the Board's newsletter 2002, it was reported that it was pursing those pharmacists and others who misrepresent themselves as doctors.

2.8 Health Incidences Reporting Systems

Several incident reporting systems are presented and analysed focusing on the architecture and highlighting the similarities and differences. The limitations of these systems are also noted.

2.8.1 Flu Incident Reporting on Mobile Phone in Thailand

The flu incident reporting mobile application allows users with mobile phones to enter information about flu incidents into a form to report illness symptoms, date, location and other information (Panyasoponlert, 2011). Users of the system can use their mobile phone coupled with our server and database to report possible incidences of disease, to see statistics reports and to see real-time flu incident map with markers showing infected area (Piboonudompornkul, 2012). The mobile application uses a client-server model, the client is the mobile phone or tablet equipped with the Android Operating System while the server is a computer which provides database and communication services (Goldin, 2012).

2.8.2 Mother and Children Health Reporting System in the Rural West Bandung Area

Digitalization of maternal and post-natal care system (DigiMAPS) is a system consist of electronic medical record for mother and children health (Faried, Djuwantono, & Hariyanto, 2015). The system is used for reporting, data collection and services to patients in Indonesia. The data collected is very useful for area-based health surveillance reports and the system uses a multimodal communication concept in order to allow prospective users such as midwifes and doctors can access the application anywhere anytime from any devices (Sutiono, 2015).

The system has several limitation.

i. The system does not provide secure transfer of confidential patient data.
ii. The system does not validate real-time data entry as compared to the conventional paper-based data entry.

2.8.3 Emergency Medical Reporting System in Egypt

Emergency Medical Service (EMS) are public services concerned with the provisioning of first medical aid by an ambulance to individuals in an incident of serious illness or accident injury and transporting them to the nearest hospital. EMS systems are designed to rapidly provide advanced medical care to critical patient cases. The application allows citizens in Egypt to make a faster, easier and more accurate incident reporting. In addition, the application works together with the other components of an integrated system to enable the EMS make better call screening and dispatch (Ghada , 2016).

In case of an emergency, the user will perform a single click on the application logo to run the application. When the application runs, it will start the device's GPS automatically to determine the position. If vital signs capturing devices are connected, vital signs will be captured. The application will then send user data, position and vital signs and medical history to the application at the ambulance control room. If the vital signs captured are life threatening, the mobile application searches for nearby vehicles that have self-reported their positions and pushes vital signs, patient's medical history and position to the nearest vehicle if available. The vehicle receives the data, notifies the EMS side application and diverts to the incident. An alternative should be provided in case a vehicle diverts while on its way to a case (Abou El Safa, 2016). Figure 2.4 shows the EMS application used in Egypt.

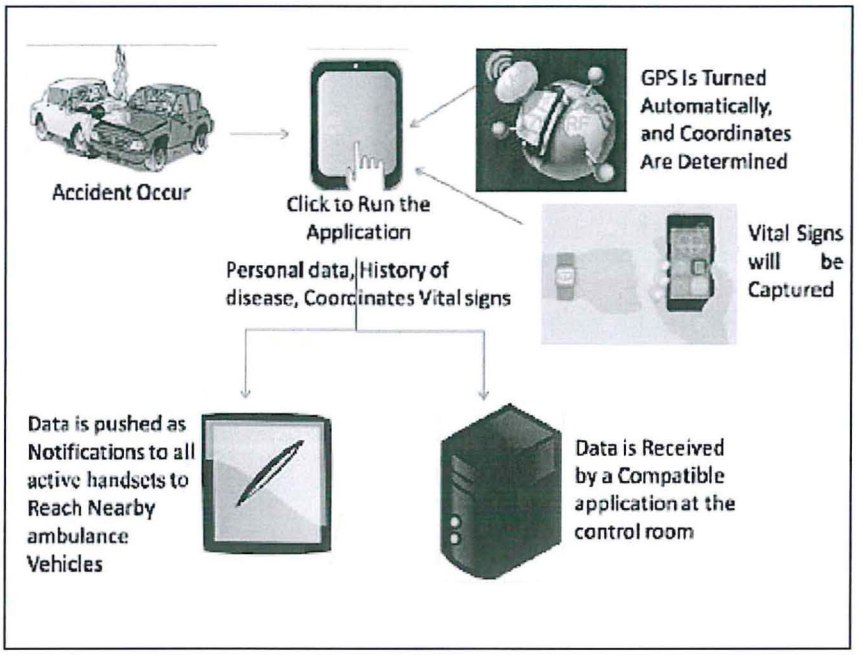


Figure 2. 4 How the Mobile Application Works in Integration with Other System Component (El Khayat & Abou El Safa, 2015)

2.9 Application Used in Locating Practitioners and Health Facilities

This section lists a number of application used in searching for registered doctors and licensed health facilities in different parts of the world.

2.9.1 A Traditional Health Practitioner System Used in South Africa

Traditional health practitioner mobile application is used in helping patients to locate traditional health practitioners much easier in South Africa. The application was developed using HTML5, JavaScript, JQuery, PHP and MySQL. The application takes advantage of the Google Maps APIs to find the nearest location of traditional health practitioner. The system is a web-based mobile application and in the Figure 2.5 shows the system architecture (Hans, 2015)

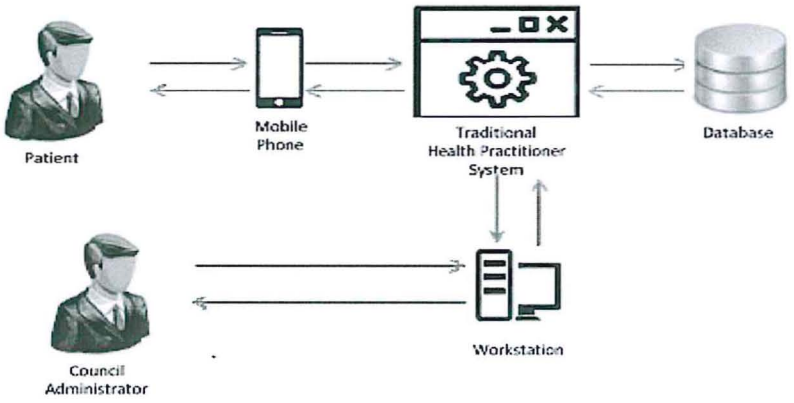


Figure 2. 5 Traditional Health Practitioner System Architecture

(Hans, 2015)

2.9.2 AutoHS Hospital Search System Used in India

AutoHS is a cloud-based crowdsourced system that helps disaster victims locate nearby licensed health facilities that meet their medical requirements using data provided by a distributed network architecture. AutoHS platform contains a list of hospitals with information of resources availability and the queue length for each of the resources the victim has requested. In addition, routing information is provided on request using the Google maps API so that victims can carefully examine the route to the hospital they plan to go to and factor this into their decision. The architecture and implementation of AutoHS are summarised in the figure 2.6 below.

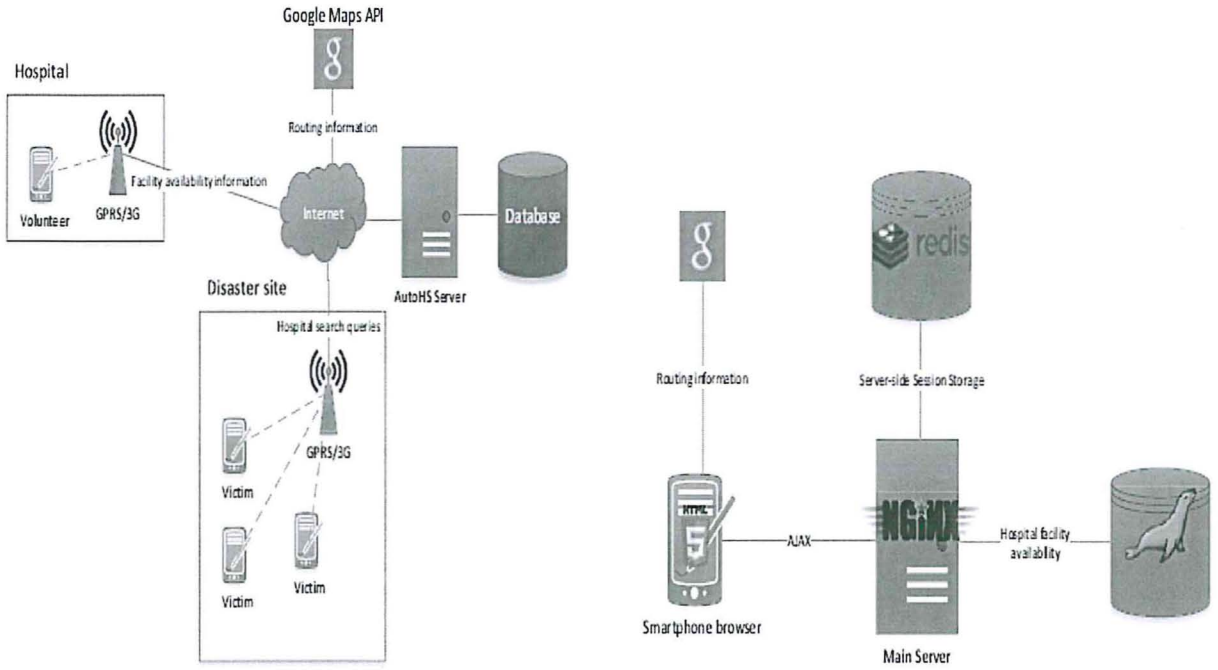


Figure 2. 6 The Architecture and Implementation Technologies of AutoHS (Rohith, 2014).

2.9.3 Dodgy Doctors Web-based Platform

i. Nigeria

The new Dodgy Doctors service uses official MDCN data to help citizens quickly and easily check whether the doctors are properly registered, and whether they are in good standing with the medical authorities (Arenstein, 2015).West Africa's largest news site, Sahara Reporters, partnered with Code for Nigeria to launch the Dodgy Doctors platform. The toolkit allows you to verify that your doctor is a licensed medical practitioner (Adeoye, 2015). Users only need to type the doctor's name in, and the service cross-checks it with the MDCN's master registry. The new Dodgy Doctors tool empowers citizens to proactively protect themselves against scammers by running a simple check on MDCN's database. Figure 2.7 below is the dodgy doctor platform used in Nigeria

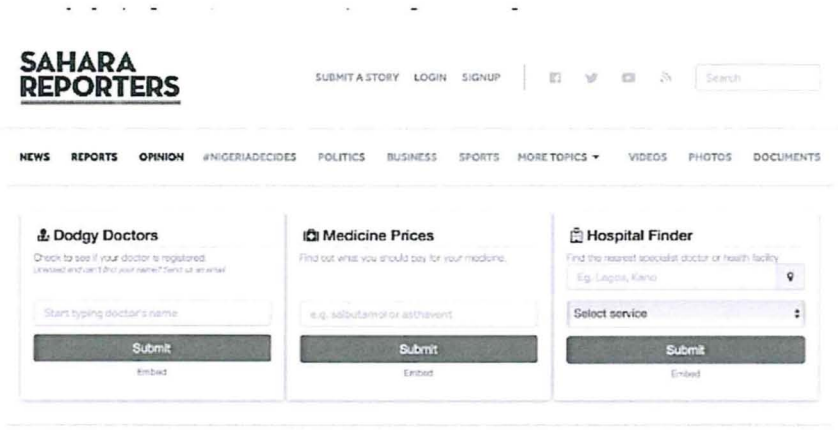


Figure 2. 7 Dodgy Doctors Platform in Nigeria (Sahara Reports, 2010).

ii. Kenya

Dodgy Doctors is the first Kenya health data portal and it was developed in 2013 (Star, 2013). The health portal is a result of the joint collaboration between the Star and Code for Kenya, the local chapter of Code for Africa. The information is provided for free online while the SMS query costs Sh10. Patients while waiting in the doctor's office, can check whether the practitioners he or she is waiting to see is registered. For the cost of a single SMS, a user can determine the doctor's authenticity. They can send another SMS that will confirm if the health facility is licensed. Figure 2.8 shows the dodgy doctor platform used in Kenya.

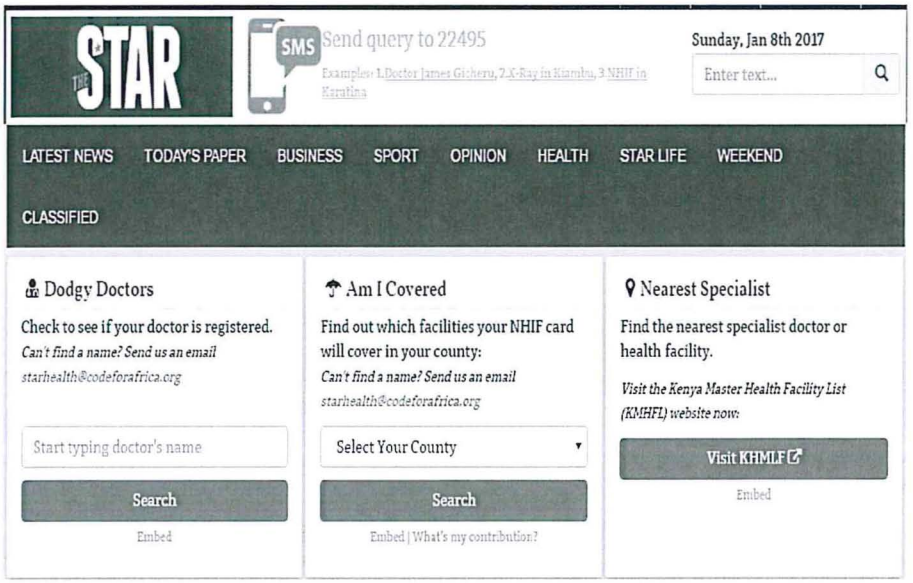


Figure 2. 8 Dodgy Doctors platform in Kenya (Star, 2014).

2.10 Gaps and Limitation on Existing Technology

Currently there is no systematic way of reporting unqualified practitioners and unlicensed health facilities in Nairobi, Kenya. Citizens can search for qualified practitioners and health facilities in Kenya is through the Kenya Medical Practitioners and Dentistry Board website which displays a list of qualified doctors, dentists and licensed health facilities. The website is very slow and allows a limited number of users to search at the same time. The platform does not provide a module where citizens can report doctors who are found practicing without a license from the medical board.

Despite the efforts made by KMPDU in eradicating unqualified health practice through crack downs there still exists gaps. One of the gaps being lack of real-time reporting platform for unqualified practitioners and unlicensed facilities by the public. The use of SMS is also available technology for addressing the problem of identifying qualified practitioners and facilities in Kenya. Unfortunately the cost of accessing such a service is still too high for citizens in the country.

2.11 Conclusions

The chapter has covered the challenges faced by patients while identifying qualified medical practitioners and health facilities. Different solution was discussed in depth. The existing solutions and technologies have been reviewed exposing their limitations and hence paving way for the possibility of adoption of combination of technologies in the existing models for the proposed system. The research gap has backed up the need for development of the proposed system. The next chapter discusses the methodology to be adopted in the development of the proposed solution.

Chapter 3: Research Methodology

3.1 Introduction

Research is defined as a fact finding activity that involves a scientific investigation or thorough study of given subject matter of particular interest. A research can be explorative, descriptive or diagnostic in nature and thus qualitative or quantitative approaches are applied as per the research design. Research has been proved to be a vital tool that provides the basis for economic decision making by government institutions and policy makers (Makey & Gass, 2013).

3.2 Software Methodology

The system methodology used in this study was Agile Methodology. Agile Development methodology allows flexibility in integrating user requirements due to its incremental and iterative nature. Design, testing and implementation was done throughout the project cycle. The fundamental concepts to agile development are simple design principles, large number of releases in a short time frame, extensive use of refactoring, pair programming and testing during development (Boem & Turner, 2003). Agile development has five main phases which include the Planning phase, Requirement analysis phase, Design phase, Building phase and the Testing phase.

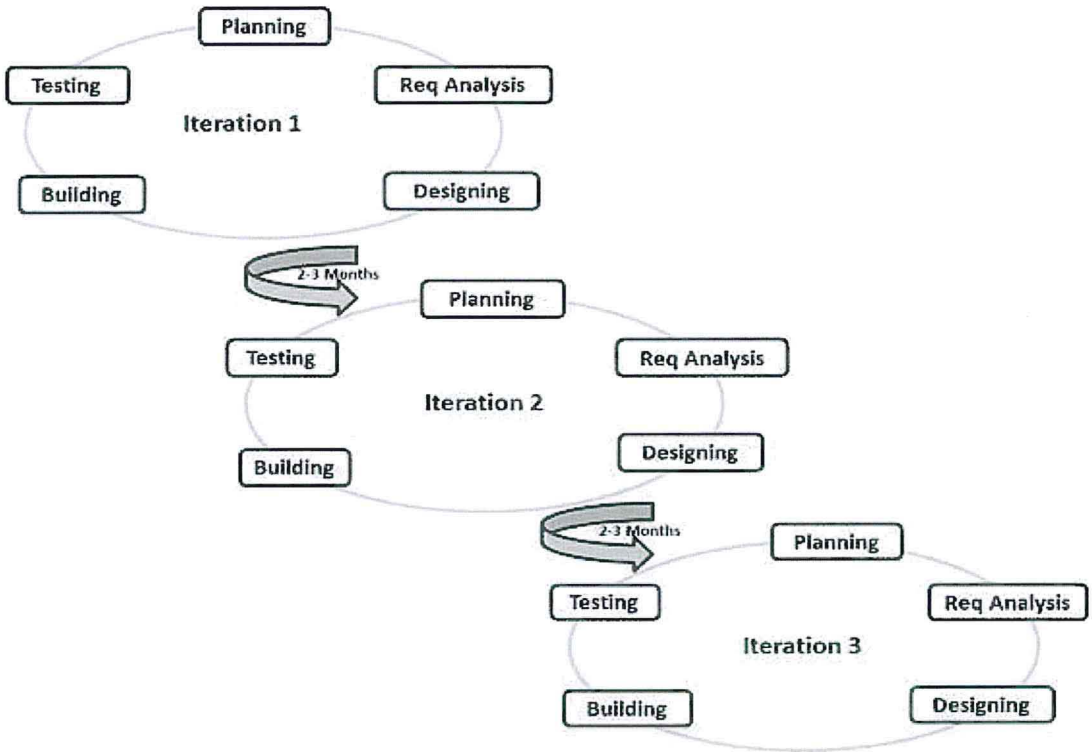


Figure 3. 1 Agile Development Methodology (James & Walter, 2017)

3.2.1 Planning Phase

This is the first phase of the methodology and its core function is to enable planning of how the entire process will be undertaken (Highsmith, 2011). Planning will help to identify the resources that were needed to build the system.

3.2.2 Requirements Analysis Phase

This second phase involves analysing the requirements of the system and what is expected of the system. Requirements analysis was used to reveal important information like what the client wants, what tools will be needed to develop and test the application and what is needed to make the development process a success.

Location of the study

The study was be done at Madaraka estate area for data collection within the County of Nairobi. The area was selected for study due to easy access by the researcher and also due to its strong presence within the area of research.

Target Population

The target population is the group of elements to which the researcher wants to make inference (Fricker, 2013).The target population was drawn from citizen visiting health care facilities within Thika road area in Nairobi.

Sampling Strategy

The researcher used Stratified Sampling technique. The stratum consisted of individuals visiting public and private clinics. These individuals were chosen as subjects to be interviewed for the study. This technique aided in focusing on the population that was most expected to interact with the proposed application.

Sample Size

25 respondents were interviewed daily for a span of 8 days. The total number of respondents interviewed was 200. This sample size also_comprised of mixed gender, age, educational level and either employed or not. The sample size was deemed appropriate as it consisted of individuals that were highly likely to interact doctors in the public and private facilities.

Data Collection

Interviews were used to obtain information from the patients and Medical Board staff regarding demand, requirement and the common tools used for verification. This was used to understand the process of reporting a quack and an unlicensed health facilities, the verification

tools, similar applications and system used in detail. The questionnaire shown at Appendix A: was given through an online-survey sent to citizens who have been treated by quacks and who have visited unlicensed health clinics. This was done to gather information about the demand and requirements of the application.

3.2.3 Design Phase

The design of the system was done after the requirements analysis is complete. This guided the researcher to understand what is needed to analyse data flow systematically, process data, store data and output information in context of the study (Kendall & Kendall, 2013). Unified Modelling Language (UML) notion was used for modelling and designing diagrams to offer a clear picture of the system to be developed. The study employed four different UML diagrams for its design. These diagrams include a use case diagram, database schema, sequence diagram and context diagram.

Use cases was used to identify and separate system functionalities in terms of who will be responsible for it, thus coming up with actors and uses cases. The actors of this system are the patients, Medical Board staff and the system administrator. The use case is in text for describing the action performed by the actors on the system (Object Management Group, 2005).

The sequence diagram was used to show interaction between the objects. This gave a clear picture of how the system flows from one point to another (Object Management Group, 2005).A database design was generated out of the entity relationship diagram (ERD) that shows various entities and their attributes and how they are related to one another (Object Management Group, 2005).

Wireframes were designed using an online platform known as Balsamiq, as it is simple to use yet very powerful with all the necessary features already provided for free. This allowed the developer to have a clear view of how the interfaces looked like in terms of the total user experience.

3.2.4 Building Phase

This was the actual implementation phase of the designs that was done on the previous phase. The database was created from the Entity Relationship Diagram (ERD) to bring out all the tables and their relationships. The designed mock-ups was transformed into the actual system and the functionalities will be added.

Prototype Development

This involved coming up with a mobile application that will be connected to a central remote database. The application development environments that will be employed are:

a) Mobile Application

The platform for mobile application implementation will be Android. The source code will be written in Java utilizing Android classes. The reasons for choosing Android for developing the client application are; availability of a flexible software development kit (SDK), Android Development Tools (ADT) availability and support for online developer communities.

b) Integrated Development Environment (IDE)

The IDE to be used will be Android Studio. This is because it is the recommended IDE by Google for developing Android applications. It is also easy to use and there is a vast amount of resource and tutorials.

c) Database

The mobile application will communicate with a MySQL Database Management System (DBMS) and a backend API implemented. The reason for MySQL database is because it is simple to implement and there is plenty of documentation on it.

3.2.5 Prototype Evaluation and Testing Phase

The prototype consisted of the following tests to find out whether it met the specified goals of this dissertation:

i. Compatibility Tests: compatibility test was performed on different versions of mobile and web-based applications on different Android based platforms and browsers respectively. Chrome browser and Mozilla browser will be used.
ii. User Tests: this test was done on the developed application to measure user satisfaction and collect feedback for refining the prototype. A questioner was used to measure user satisfaction and collect feedback.
iii. Validation: users of the application were able to test whether it works as it should. User's satisfaction was used to verify the system.

3.3 Ethical Issues

Research ethics is critical since it guides the interactions with people, organizations and institutions. The research sought authorization for data collection from institution and participants by explaining the purpose and important of the study. Privacy and confidentiality was employed to ensure

that the data collected from respondents is kept safe, free from interference and protected from unwanted use.

Chapter 4: System Design and Architecture

4.1 Introduction

System design and architecture involved the design of the system architecture both the front – end and back-end sides of the application outlining the various requirements needed for the implementation of the application. This involved the presentation of the context diagrams, sequence diagrams, use case diagrams, entity relationship diagrams (ERD) and wireframes.

4.2 Data Analysis

Data was collected using the questionnaires in (Appendix A) created using Google forms and sent to respondents via email.

4.3 Degree of Response

The target population included citizens that visit both public and private health facilities. It was of essence to know whether the citizen have been to a public or a private health facility, if they have ever encountered a fake doctor, how they were able to identify that the doctor was a fake doctor or a genuine doctor and how they reported the incidence to the authority. Below is the analysis of the data obtained from the respondents.

i. Hospital Facility

All the respondents were asked to specify the health facility they have visited. Figure 4.1 shows the health facility distribution of all the respondents either the public hospital or the private health facility.

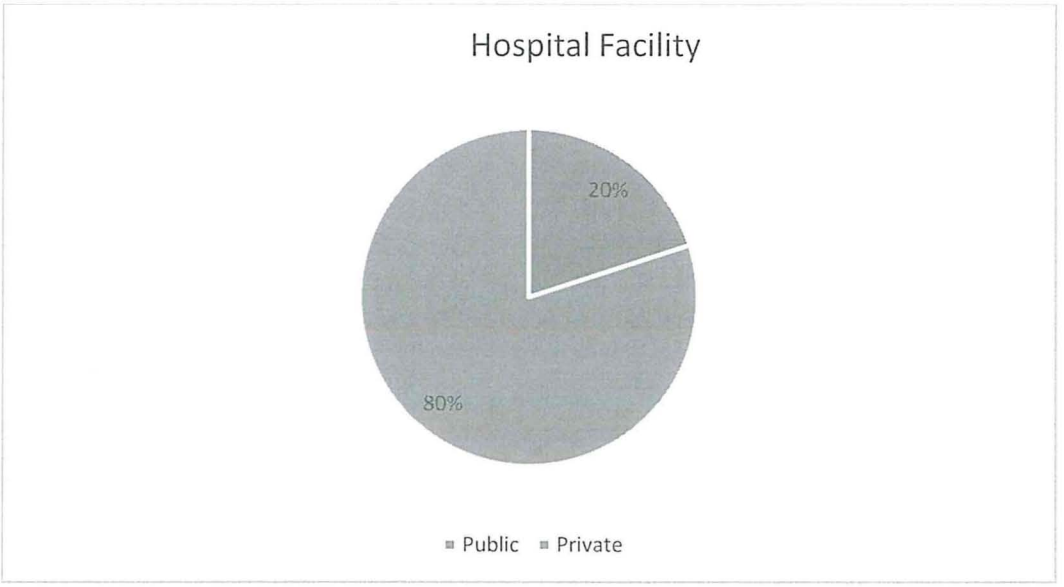


Figure 4. 1 Hospital Facility

ii. Citizens Treated by Fake Doctors

The respondents were asked to indicate whether they have encountered a fake doctor while receiving treatment from the health facility.60% of the respondents have encountered a fake doctor while 40% had not encountered a fake doctor.

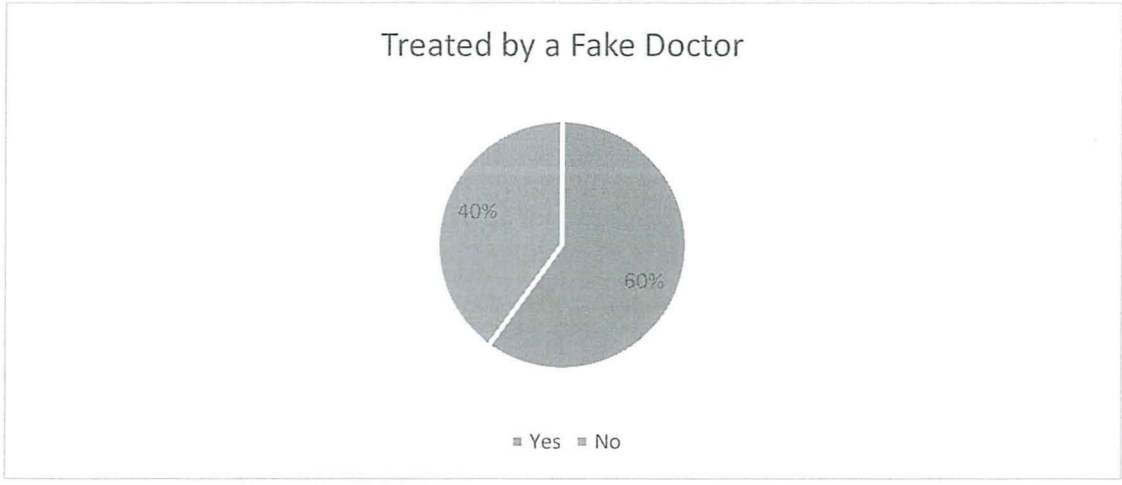


Figure 4. 2 Treated by Fake Doctors

iii. Reporting Channels

All the respondents as shown in Figure 4.2 indicated that they had encountered a fake doctor when receiving treatment were further asked if they had reported the incidences and the reporting channels they used to report the fake doctor. Figure 4.3 shows different reporting channels used.

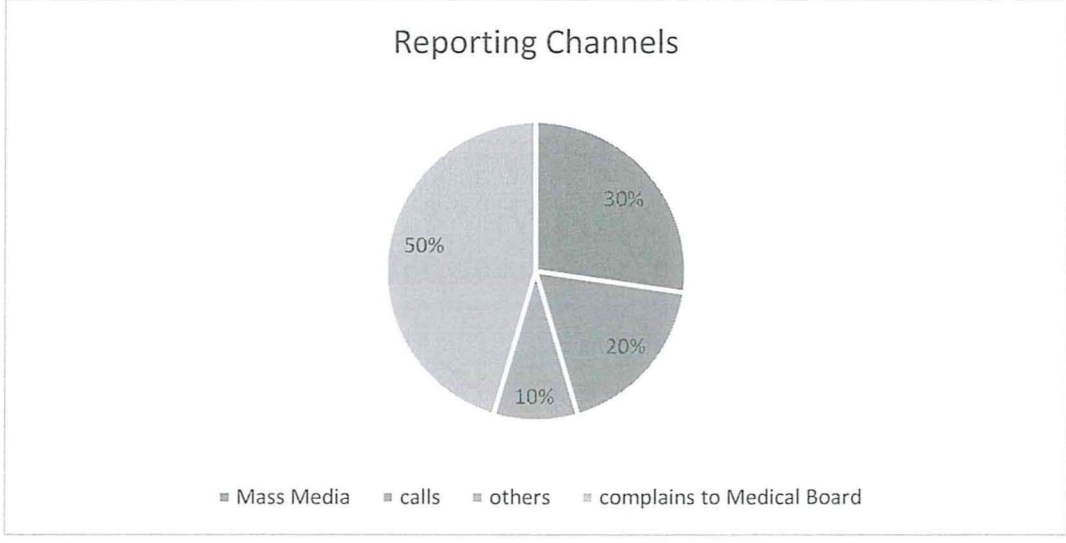


Figure 4. 3 Report Channels

iv. Ownership of Smart Phone

The system uses mobile technology hence it is vital to know smart phone availability among the users. Apart from a few users who reported of not having mobile phones, most of them owned smart phones. Figure 4.4 illustrates mobile phone ownership.

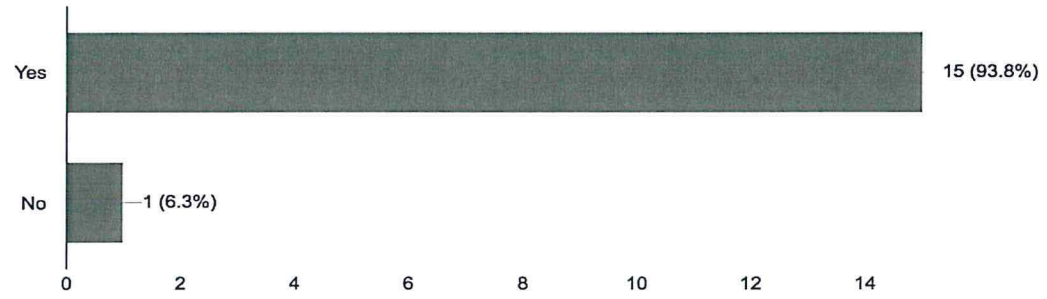


Figure 4. 4 Ownership of Smart Phone

v. Operating System of Mobile Device

The respondents were asked to indicate the operating system on their mobile phones in order to have a solid base on which the operating system should the system be based on. Figure 4.5 shows most users have Android phones 80%, 10% have IOS phone and 10% have Windows phone.

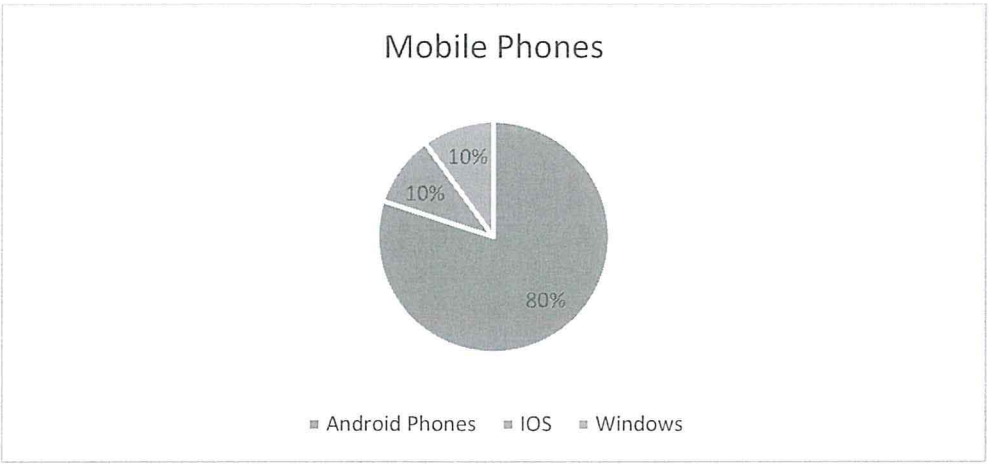


Figure 4. 5 Operating System of Mobile Device

4.4 Results from Data Collection and Analysis

The responses received from the respondents was highly valuable and very informative in making the decision of whether to the proposed system was feasible. The features of the system were refined based on the feedback collected by the researcher. The findings that were derived from the respondents were; the proposed solution would be feasible for identifying and reporting the existence of unqualified health practitioners and unlicensed health facilities in Kenya especially in Nairobi. It was evident that Android was most popular and accessible operating system to majority of the population, therefore it was most preferred platform for development of the application. The results was very useful in coming up with the system requirements that aided in designing the system and in the implementation process.

4.5 Requirements Analysis

The requirements were elicited from different people that included: doctors, victims of quack malpractice and staff of the Medical Board. Data was collected through different data collection tools and analysed to come up with the requirements for the proposed scheme to meet their requirements. From the analysis the following requirements were identified and divided into functional and non-functional requirements.

4.5.1 Functional Requirements

Functional requirements are the requirements that the application should fulfil to satisfy all the needs required by the application users. The requirements include: verify doctor, verify hospital, verify facility licence, report unqualified practitioner and unregistered health facility and create awareness of basic information of licensed health facility and registered health practitioner.

Verify doctor allows the user to search for a licensed health practitioner and view the profile of the health practitioner. Verify hospital facility allows the user to search for a licensed health facility and view the facility details. Verify facility license allows users to scan the license facility to verify that it is genuine. Report enabled the users to report unqualified health practitioners and unlicensed health facility that are operating without registration. Useful information was used in creating awareness of basic information on health facility and licensed health practitioners.

4.5.2 Non-functional Requirements

These are requirements that are not necessary to the core functions of the application but they still are part of the application and they improve the user experience. The first requirement for the application is usability, the application should be easy to use and interact

with. The application should provide seamless and fully unified experience. In terms of performance the response time should be acceptable. The application should be well designed to be appealing and to enable users to navigate without much assistance.

4.6 Design Phase

This section was used explain the design and architecture of the system developed as a proof of concepts. A database was used and the database schema will be discussed below as well as the UML diagrams used to further design the system and show how the user interacts with the system.

4.6.1 System Architecture

The front-end user is the patient in possession of a mobile phone with the application installed. The front-end user can search for a registered doctor using the doctor's name and can also search for licensed facilities using the facilities name. The user can report in the event that the doctor and health facility does not exists in the database. The front-end users have the option to view the profile of the doctor and the hospital facility. The information of registered practitioners and health facility is stored in the KMPDU website. The API connects the application to the website and the doctors and hospital information is displayed on the application. The back-end is where the data analytics of the reports made by the clients is analysed. The analysed data is represented in form of graphs and charts. Figure 4.6 shows the system architecture of the mobile application.

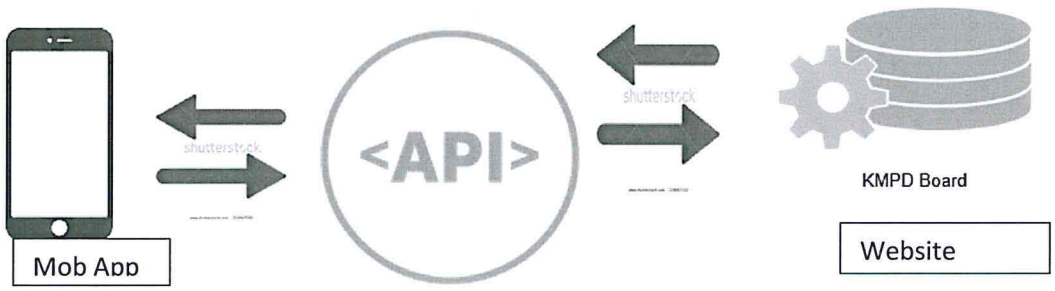


Figure 4. 6 System Architecture

4.6.2 Context Diagram

A context diagram is a component of functional modelling that stands out on its own as a valuable tool. This allows for the interest and interactions with critical elements in the surroundings (Burge, 2012). A context diagram was used to represent actors outside of the system that directly interacted with the mobile application. They consisted of entities and relationships. Entities represented the main system while multiple external entities represented external actors. Figure 4.7 shows relationship between entities representing flow of information through a context diagram.

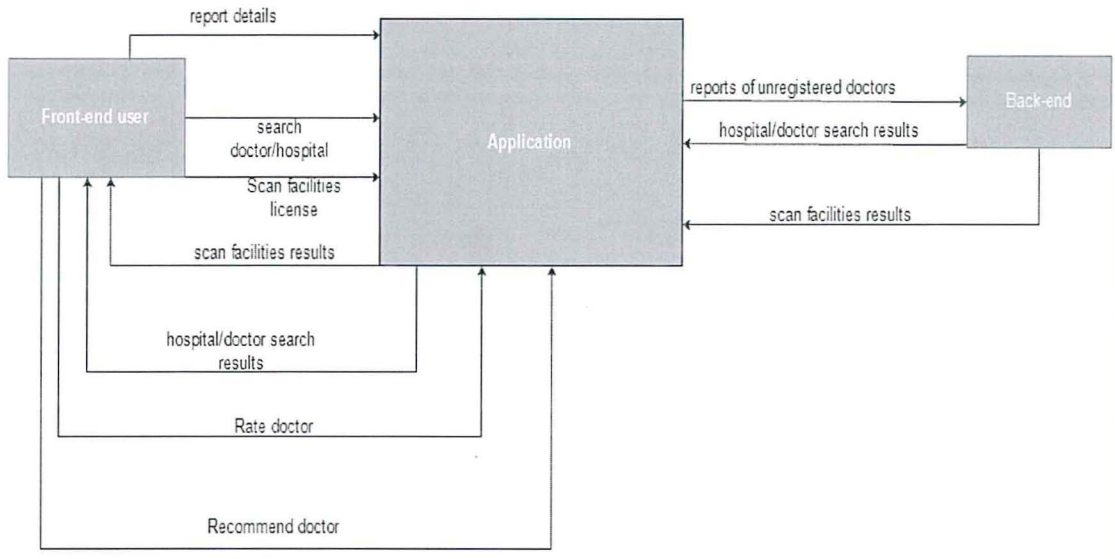


Figure 4. 7 Context Diagram

4.6.3 Sequence Diagram

Figure 4.8 shows the sequential flow of information passing through the system entities. The sequence diagram shows how events take place in respect to the main users of the application who are patients visiting a health facility. After downloading the mobile application the users can search for a doctor and a health facility. The user can also report the unlicensed doctor and health facilities. The application allows users to scan the facility license and verify that it is genuine. The system shows the expected results for each request a user makes.

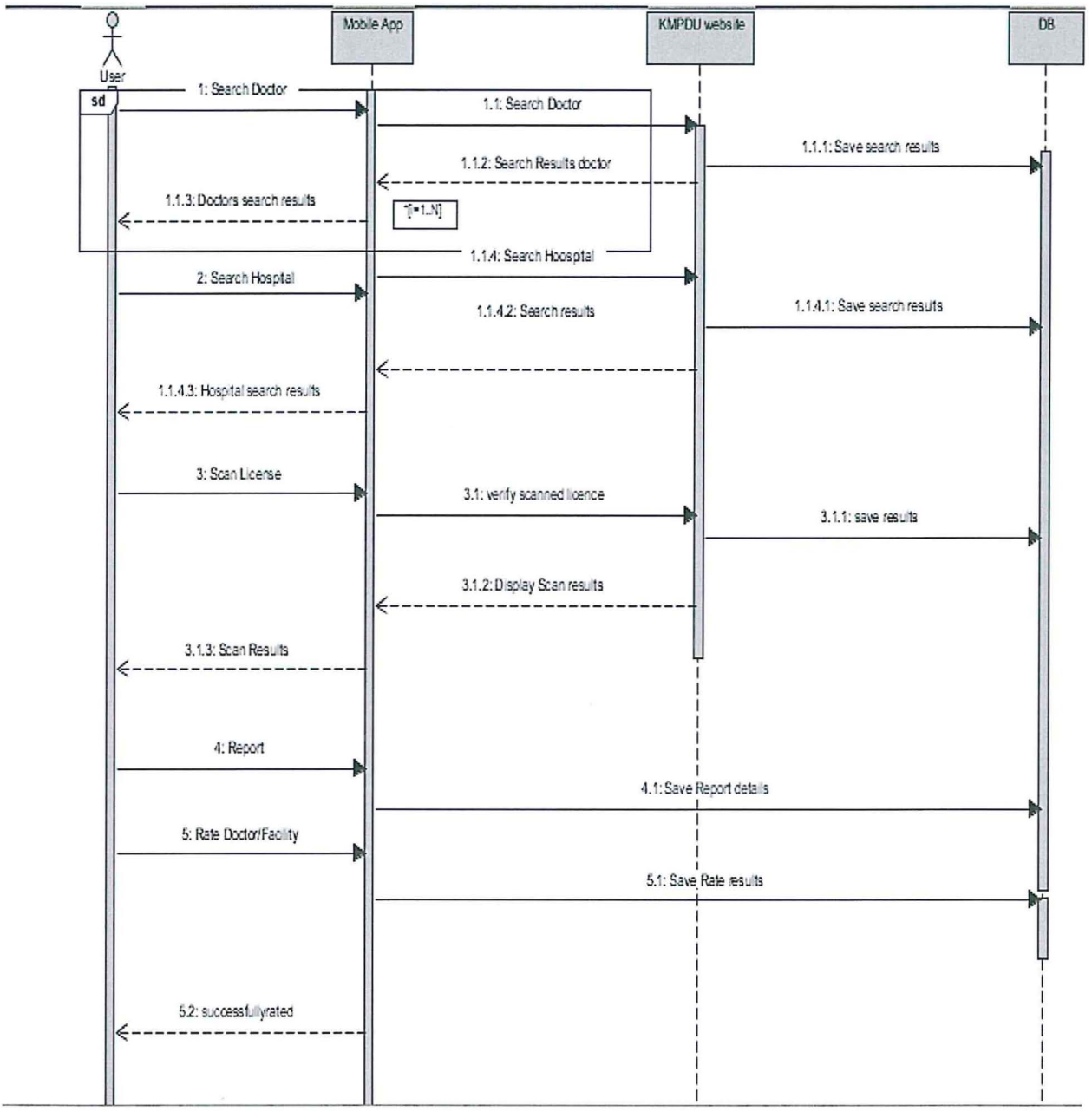


Figure 4. 8 Sequence Diagram

4.6.4 Use Case Modelling

A use case diagram at its simplest is a representation of a user's interaction with the system. Use cases are used to model the various processes in the system and how external entities interact with them. The actors here include: patients, staff of the Medical Board and the system administrator. Figure 4.7 illustrates the use case diagram with all use cases.

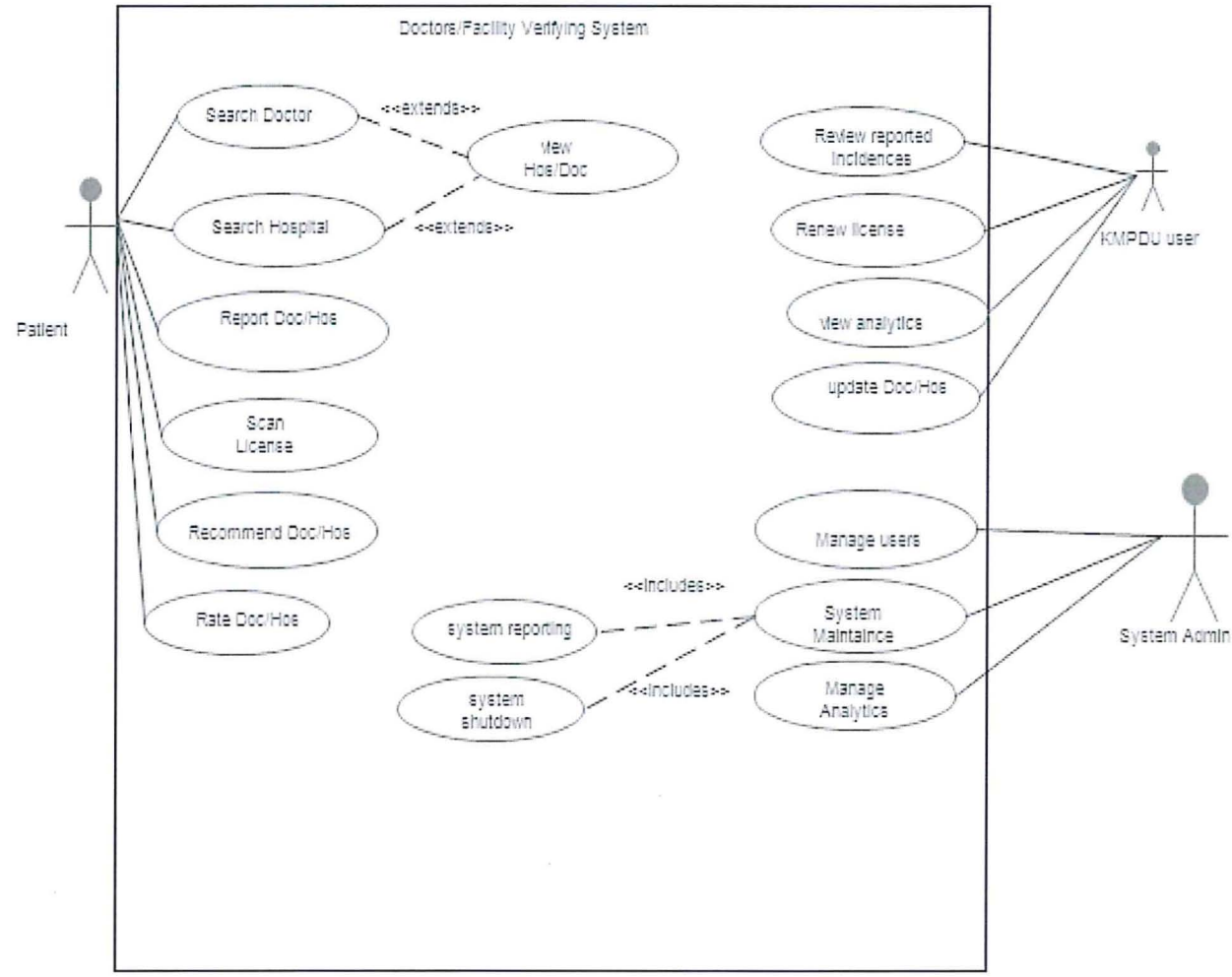


Figure 4. 9 Use Case Diagram

The use case description of the proposed mobile application. It comprises of the following major Use Cases; Search Hospital, Report Unregistered Doctor/Health Facility, Rate Doctor/Hospital and Scan Licence Facility. The Table 4.1 and 4.2 describes the major use case of the application.

Table 4. 1 Search Doctor/Facility Use Case Description

Use Case Name	Search Doctor/Facility
Description:	A patient can search for a registered doctor and a health facility using the name.
Primary Actors:	Patient.
Precondition:	The user must enter doctor's name and registration number.
Post condition:	The doctor's details already exists in the database.
Typical case of Events **Actor Response** 1. Search for registered doctors. 2. Verify the doctor's details.	**System Response** 1. Displays the information of the doctor 2. View the displayed results

Table 4. 2 Report Hospital and Doctor Use Case Description

Use Case Name	Report Hospital facility/Doctor
Description:	Describes how users reports unregistered doctor and hospital facilities
Primary Actors:	Patient.
Precondition:	The user must search the doctor/facility using the correct information
Post condition:	The user searched details is not in the database.
Typical case of Events **Actor Response** 1.Report for unregistered hospital/doctor 2.Verify the report of unregistered hospital	**System Response** 1.Displays the reported details of unregistered hospital/doctor 2. confirmation message of report made by users

Table 4. 3 Rate Doctor/ Hospital Facility

Use Case Name	Rate Doctors/Hospital
Description:	Staff updates doctors/hospital details
Primary Actors:	Staff, system admin
Precondition:	The doctors and hospital details is saved in the database.
Post condition:	The doctor's details is updated in the database
Typical case of Events **Actor Response** 1. The details of doctors and hospitals reviewed yearly 2. Details of the doctor and hospital updated in the system	**System Response** 1. Displays the updated results of the doctor and hospital 2. Confirmation message of the updated results

Table 4. 4 Rate Hospital/Doctor Use Case Diagram

Use Case Name	Rate Doctor/Facility
Description:	A patient can rate a doctor and a health facility
Primary Actors:	Patient.
Precondition:	The user must review the doctor name and registration number.
Post condition:	The doctor's details already exists in the database.
Typical case of Events **Actor Response** 1. Search for registered doctors. 2. Verify the doctor's details.	**System Response** 1. Displays the information of the doctor 2. View the displayed results

4.6.5 Entity Relationship Diagram

Figure 4.10 illustrates the entity relationship diagram that illustrates the conceptual view of the database as well as the relationship between tables.

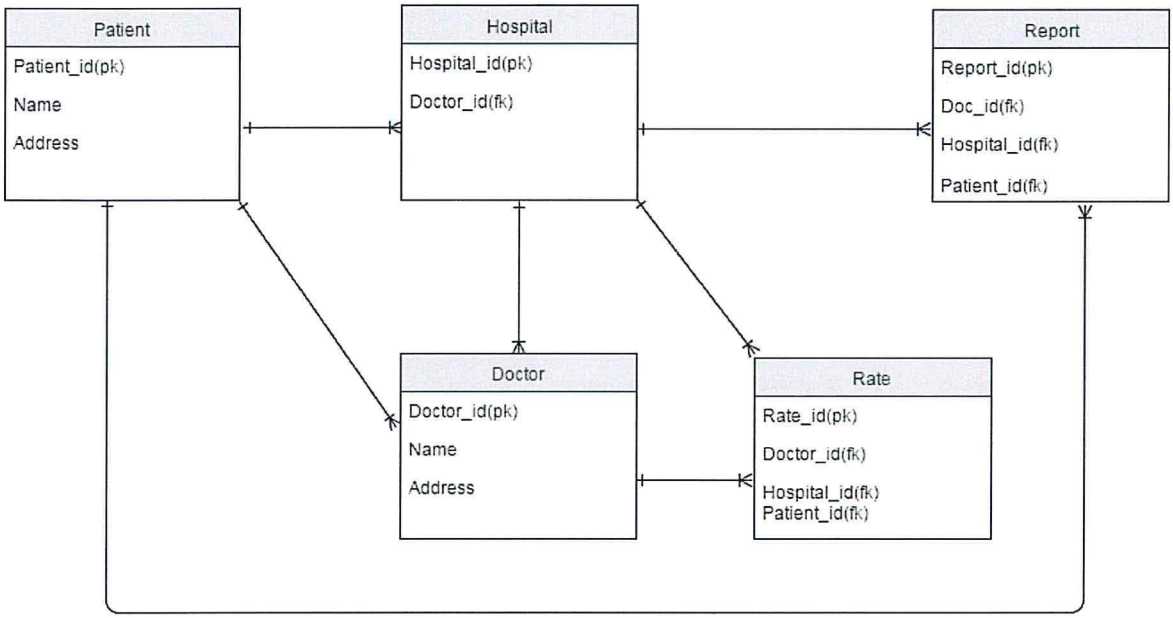


Figure 4. 10 Entity Relationship Diagram

Table 4. 5 Database Tables Overview

Table 4.5 below is the overview of the entities of the database and their description.

Table Name	**Description**
Doctor table	This table contains registered doctor's information.
Hospital table	This table has details of licensed hospital facility.
Patient table	This table has patient details. Patients details is recorded when they rate and report doctors and health facility.
Report table	This table has information of the facility that have been reported and unlicensed doctors found operating without a license
Rate table	This table has information of the rated doctor and the health facility.
Scan license table	The scan license table has information of scanned hospital license.

4.6.6 Database Schema

The following tables shows the entities and the fields as well as their corresponding primary and foreign keys included in the database design.

Table 4. 6 Doctor's Table

Table 4.7 shows the doctors Table that includes the detailed information of doctors

Column Name	Data Type	Index
Doctor-id	Varchar(30)	Primary key
Name	Varchar(30)	
Address	Varchar(30)	
Qualifications	Varchar(30)	

Table 4. 7 Hospital Table

Table 4.8 shows the doctors Table that includes the detailed information of hospitals

Column Name	Data Type	Index
Hospital-id	Varchar(30)	Primary key
Doc-id	Varchar(30)	Foreign key
Name	Varchar(30)	
Address	Varchar(30)	
Facility type	Varchar(30)	
capacity	Varchar(30)	

Table 4. 8 Report Table

Table 4.8 shows the report Table that includes all the reports made by the users.

Column Name	Data Type	Index
Report-id	Varchar(30)	Primary key
Doctor-id	Varchar(30)	Foreign key
Hospital-id	Varchar(30)	Foreign key
Date	Varchar(30)	
category	Varchar(30)	

Table 4. 9 Rate Table

Table 4.9 shows the rate Table that includes all the ratings of the hospital/doctors made by the users.

Column Name	Data Type	Index
Rate-id	Varchar(30)	Primary key
Doctor-id	Varchar(30)	Foreign key
Hospital-id	Varchar(30)	Foreign key
Patient-id	Varchar(30)	Foreign Key
category	Varchar(30)	

4.6.7 Wireframes

The user interface was modelled using wireframes. A wireframe is a low-fidelity representation of a system design. The wireframe diagrams can be found at Appendix C. Figure C.1 shows the splash screen when the users starts the application. The user is allowed to select either health facility or the registered doctor. The user can search for a health facility or a doctor using a name as shown by Figure C.2. The search results is displayed in Figure C.3. The report screen allows the user to report unlicensed health facility and unregistered health practitioner as shown by Figure C.4.After reporting the incidence it is displayed on a map with a brief description of the reported incidence.

A user can also scan the healthy facility licence to authenticate if it is genuine or not. The users can also view useful information from the useful information module as shown by Figure C.5.The application will also have a website backend where the data analytics will be done. The website will have a registration and login for the administrator and the staff of the Medical Board as shown by Figure C.6 and C.7. Once logged in the administrator will be able to view the reported incidence and the analytics will be displayed for the staff of the Medical Board to view and make decisions based on that. The wireframes of the system both the mobile and the web application are discussed and the figures represent how the system will function.

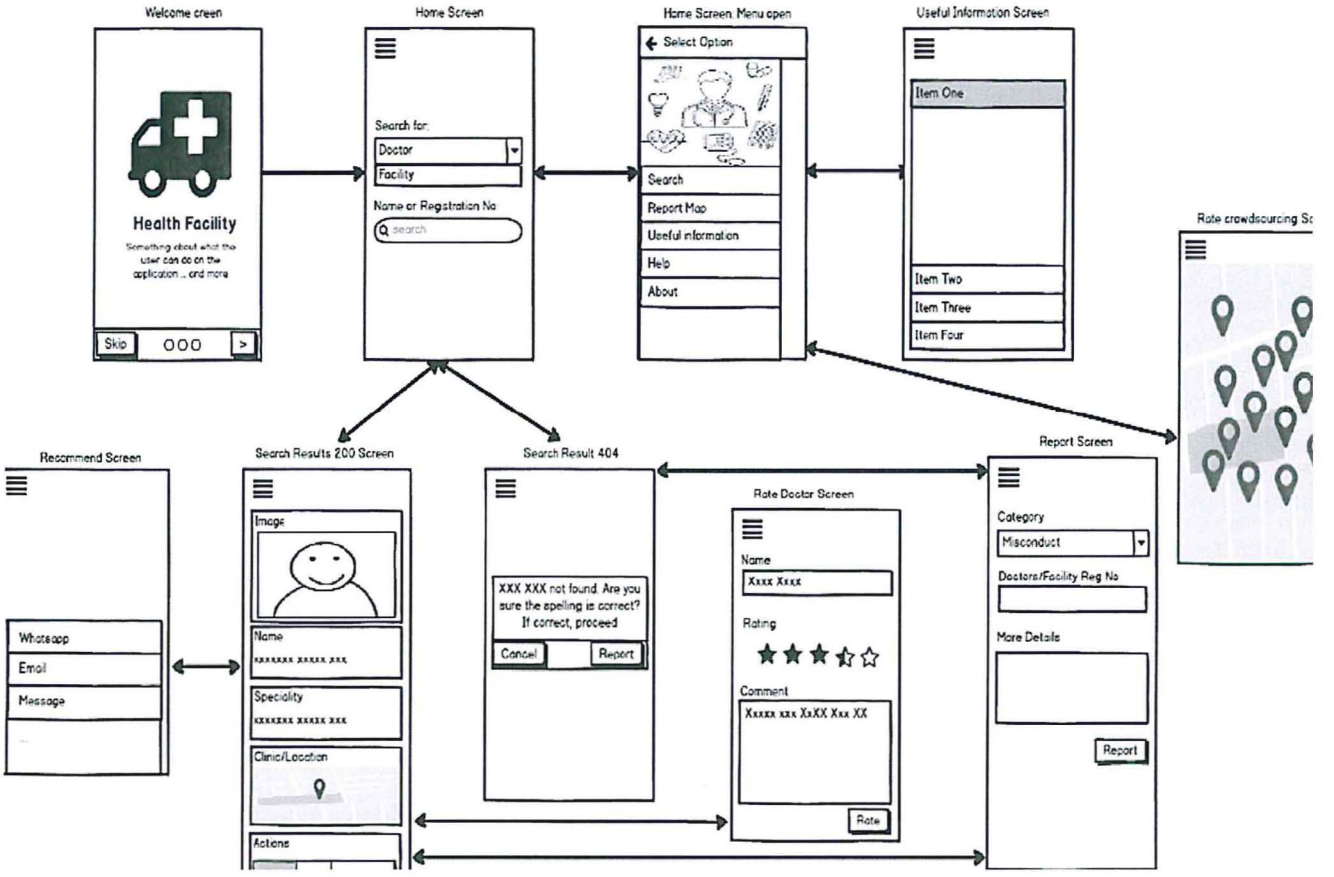


Figure 4.11 Wireframe of Mobile Application

Chapter 5: Prototype Building and Testing

5.1 Introduction

This chapter focuses on the development of the application and explains the implementation of the system functionality and the requirements needed for the application to function. Screenshots will be provided to show the different system modules and how the user interacts with the application.

5.2 Implementation Environment

5.2.1 Hardware Environment

The application runs on an Android device version 5.0.2, quad-core processor of 1.3 Gigahertz of processor speed, 1 Gigabytes RAM capacity and a 16 Gigabytes hard drive capacity with a 5.5-inch screen size. Desktop computer specifications include a 4 Gigabytes RAM capacity, core i3 processor of speed 1.9 Gigahertz and a 750 Gigabytes hard drive capacity.

5.2.2 Software Environment

The mobile application runs on an Android Operating System with the source code written in java. The application was compiled and tested using the Software Development Kit (SDK) and an Android device. The application is compatible with the latest android version 6 down to android devices on a minimum of version 2.0. MySQL is used as the database query language and JSON used as the web service language for communication between the database and the android front-end. Android is preferred due to its large online development community, availability and ease of use of Android Development Tools (ADT).

The web application is developed on a PHP framework which is Laravel 5.2 and hosted on an online apache HTTP server. PHP; Laravel was picked since it is open source and has a large community of online developers, implements the HTTPS protocol that prevents online attacks. PHP is also platform independent and compatible with all major web servers and databases. The database runs on MySQL since it is compatible with PHP and it is open source.

5.3 System Implementation

The system was implemented as both an Android mobile application and a website backend known as *Tru-Daktari*. The website backend enabled the administrator to manage the application and view reports which is useful for data analytics.

5.3.1 Mobile Application

The *Tru-Daktari* mobile application allows patients to search for a registered health facility, search for a registered health practitioners, report unregistered health practitioners and unlicensed health facility, scan health facility licence and rate and doctors as well as health facilities. The mobile application also helps users by creating awareness of basic information contained in a registered health facility as well as the way of conduct a health practitioners is supposed to conduct while on duty.

Once a user has downloaded and installed the application on their mobile phone, the user will be taken through a splash screen that gives a brief description of about the application. After the splash screen the menu screen is displayed as shown in, Figure D.2 which has a list of options that a user can select from. The search page allows the user to select either a health facility or a health practitioner from the list option as illustrated in Figure D.3.Once the user has selected a doctor or a health facility they are allowed to search using the name of the doctor or the name of the health facility as shown in Figure D.4. The user can view the details of the facility or the doctor as shown in Figure D.5. The user is able to report when the doctor is not registered or in case the health facility is not licensed as illustrated in Figure D.6.Users of the application can rate and recommend the doctor and health facility as illustrated in Figure D.7.The user can view useful information from the useful information module illustrated in Figure D.8. This module assists in creating awareness to the users of basic information of a licensed health facility and a registered health practitioners.

5.3.2 Web-Backend

. The website will have a login for the administrator and the staff of the Medical Board. Once logged in, a backend home page will appear and they will be able to view reports and statistics. The staff of the Medical Board will be able to review the reports made by different citizens which will be very helpful in decision making. The data analysed will help the Medical Board while curbing the menace of unqualified health practitioners and unlicensed health facility.

5.4 System Testing

This section describes tests that were performed on both the mobile and web application. Testing was done on four main areas; functionality tests, usability tests and compatibility tests.

5.4.1 Functional Testing

Functional tests were carried to determine whether the system design and its implementation was a success or a failure. Different use cases of the system were tested with results being flagged off as a success or fail. Below are the test cases carried out and their results.

Test Identifier 1: To Search Page

Table 5. 1 Search Page Test Case

Utilized Use Case	Search Page
Test Parameters	Searching using the correct username
Expected Behaviour	Successful Search results
Observed Behaviour	Successful Search results
Test Outcome	Pass

Table 5.1 shows results of test identifier one who's main assessment was to check for correct of both mobile and web application. The observed and expected behaviour were consistent. Test Identifier one passed the trial and outcome was deemed successful.

Test Identifier 2: To Report Page

Table 5. 2 Report Page Test Case

Utilized Use Case	Report Page
Test Parameters	Expected results from the server
Expected Behaviour	Successful reported results
Observed Behaviour	Successful reported results
Test Outcome	Pass

Table 5.2 shows results of test identifier one who's main assessment was to check for correct of both mobile and web application. The observed and expected behaviour were consistent. Test Identifier two passed the trial and outcome was deemed successful.

Test Identifier 3: Scan License Page

Table 5. 3 Scan License Page

Utilized Use Case	Scan License Page
Test Parameters	Expected results from the server
Expected Behaviour	Successful scan results
Observed Behaviour	Successful scan results
Test Outcome	Pass

Table 5.3 shows results of test identifier one who's main assessment was to check for correct of both mobile and web application. The observed and expected behaviour were consistent. Test Identifier two passed the trial and outcome was deemed successful.

Test Identifier 3: Rate Page

Table 5. 4 Rate Page

Utilized Use Case	Report Page
Test Parameters	Expected results from the server
Expected Behaviour	Successful rated results
Observed Behaviour	Successful rated results
Test Outcome	Pass

Table 5.4 shows results of test identifier one who's main assessment was to check for correct of both mobile and web application. The observed and expected behaviour were consistent. Test Identifier two passed the trial and outcome was deemed successful.

5.4.2 Usability Testing

End users of the application were involved in usability testing. This group defined the target population available to use the system. A total of 26 respondents carried out the user testing practice giving appropriate feedback for the research. 26 respondents were used as these were the only individuals who created time to be a part of the testing exercise. User testing was done to achieve the following objectives:

i. User friendliness
ii. functionality
iii. Aesthetics
iv. Acceptance

This section will focus on each of the mentioned objectives in detail. The findings will be presented graphically for an elaborative visual presentation.

i. User Friendliness

The ease of learning and using the application was tested by potential users. The results were as follows; 90% of the potential users indicated that the application was easy to learn and use. Figure 5.1 shows a summary of the results.

Figure 5. 1 User Friendliness Testing

ii. Functionality

Potential users of the application tested the system functionality against the user specifications. 80% of them indicated that they were very satisfied with the application's functionality meaning that the developer achieved most of the user functionality and requirements specification, 20% indicated that they were satisfied with the application's functionality meaning that some of the user specifications were not entirely meet. This result was used to refine the system until an acceptable application was developed. A summary of the results is shown in Figure 5.2 below.

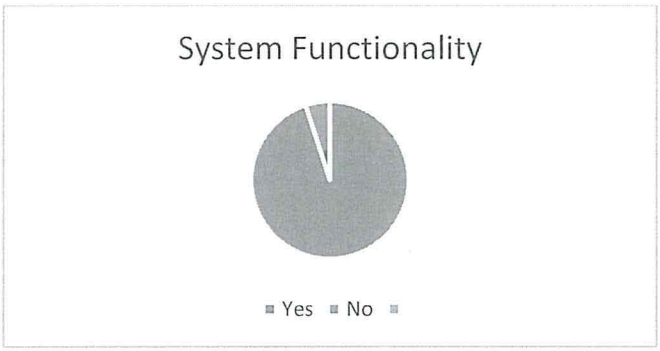


Figure 5. 2 System Functionality Acceptance Testing

iii. Acceptability

To measure if the application was great success user acceptance was tested. 90% of the potential users gladly accepted the application for use in when identifying a hospital facility and a health practitioners. 10% did not accept the application meaning that there were some aspects about it that they wish would be different. Since majority of the users gladly accepted the application this test was a great success. Figure 5.3 provides a summary of these results.

Figure 5. 3 Acceptability Testing

iv. **Aesthetics**

User interface aesthetics is defined by the look and feel of the application design and flow to its users.84% of the respondents indicated that the application had an attractive presentation. 14% of the respondents indicated that the application was acceptable while the remaining percentage indicated that the application was not pleasing to the eyes. A summary of the results can be viewed in Figure 5.4.

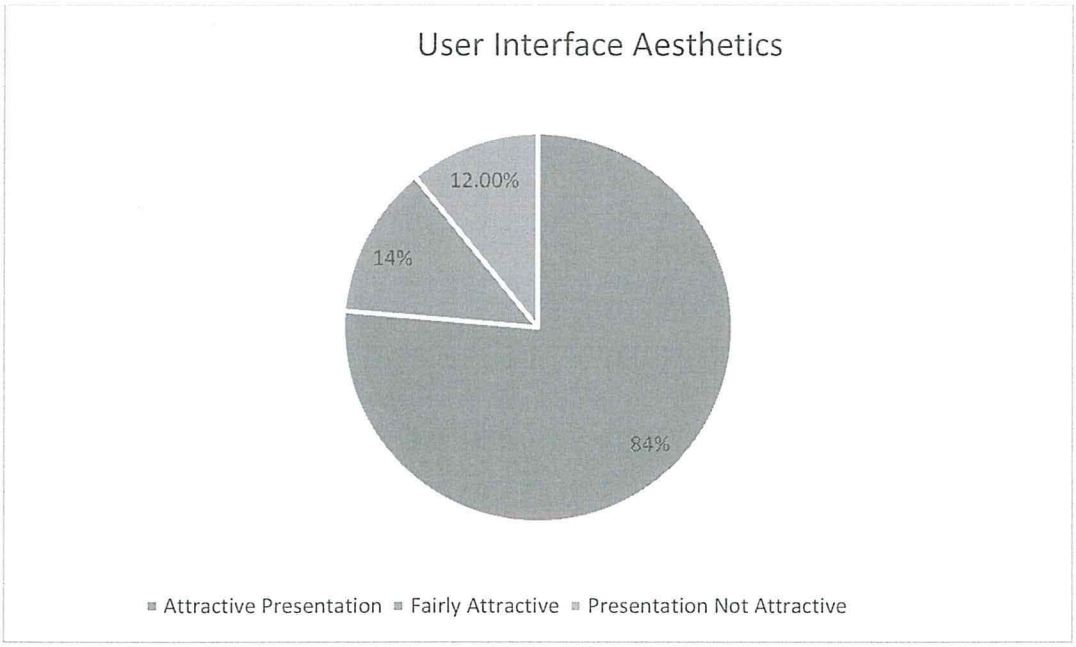


Figure 5. 4 User Interface Aesthetics

5.4.3 Compatibility Testing

Compatibility testing was done to ensure that the system; both the mobile and web application are compatible with the existing platforms. Mobile application was tested on the existing Android versions while the web application was tested on the all the major web browsers.

Android Platform Testing

The table 5.5 shows tests conducted on predefined and locally available Android platforms.

Table 5. 5 Predefined Available Android Operating System Platforms

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

Web Browser Testing

The table 5.6 shows testing done on available and commonly used web browsers.

Table 5. 6 Test done on Available Browsers

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

5.5 System Evaluation and Validation

The evaluation and validation was done to ascertain whether the system used in identifying and reporting unqualified practice solves the problem. The proposed system was passed under various test. With all the test cases done, it proved that the system in place was valid and beneficial to the organization. This was also supported by the 15 potential users. Afterwards, the 15 potential users were asked to give their view through an interview and the results were recorded. Figure 5.5 shows what the users thought of the implementation and if the system solved the problem.

Figure 5. 5 Validation of System

5.6 Summary

Fundamental information used in the system implementation stage was provided by system requirements formulated in the requirements gathering and analysis stage. Research objectives and questions were also put into consideration in ensuring that the system was implemented to achieve user requirements provided by targeted users. The overall project adhered to a majority of the proposed objectives. The research was completed in ample time for testing and getting feedback from the application. The mobile application was developed to run on the Android platform and the web based application was developed entirely for reporting and data analysis.

System testing was done in three phases: *Functionality Testing*; was done to ensure user requirements were met, *Compatibility Testing;* was done to test the mobile application to the Android platform and the web based application to web browsers, *User Testing;* was done to test User Friendliness, Application Functionality, Interface Aesthetics and User Acceptance of the prototype.

Chapter 6: Discussion

6.1 Introduction

The purpose of the research was to identify the challenges facing citizen while identifying qualified health practitioners and licences health clinics, to investigate the current techniques used for verification, to design, develop and test a mobile application and to validate the mobile application for identifying and reporting unqualified health practitioners in Kenya. This was done in order to identify and develop a suitable technique that will be adopted to address the current challenges faced while identifying a health practitioner and a licenced health. The research findings helped in identifying the appropriate technique which was adopted and a mobile and a web application for identifying and reporting unqualified health practitioner was made easier, accurate and efficient.

The mobile application was developed for use by the citizens trying to access health facilities who had access to a data enabled phone running an Android Operating System. The web application was developed and could be accessed using a standalone computer, laptop or mobile device. This chapter described the research findings and achievements, how the research objectives were achieved and it also provides a review of the application developed mentioning the advantages and limitations of the developed application.

6.2 Findings and Achievements

A review of the literature indicated the techniques used in identifying and reporting unqualified health practitioners include SMS and web based health platform. The SMS charges is expensive because a user has to pay 10 kshs to verify if the health practitioner and another 10 kshs to verify the health hospital. The manual process of performing crackdowns by the medical officers from town to town is time consuming, tiresome and expensive.

The mobile application platform is the most appropriate technique for identifying and reporting unqualified practitioners since it is fast, affordable and very reliable. However, at the present, there is no unified system tool used for reporting unqualified health practitioners and unlicensed health facilities in Kenya. This research will therefore improve on the online techniques for identifying and reporting unqualified health practitioner and unlicensed health facility. Using a mobile application will maximise on the advantages of online verification and also bridge its gaps and limitations by providing a unified system for identifying and reporting unqualified practitioners in health care.

6.3 Review of Research Objectives in Relation to the Mobile Application

This research identified the challenges faced by citizens in the identifying a legit practitioner and health facility and reporting the unqualified practice in health care based on journals, websites, books and user feedback. A mobile and web application was designed and develop with a selected

technique from the literature review and results from system analysis. The research objectives acted as a guideline to develop the mobile application.

The first objective was to identify the challenge citizen's face while identifying qualified health practitioners and reporting unqualified health practice in health care. This was achieved through interviews and questionnaires that the respondents were asked to participate in. The feedback from the users revealed a few challenges that includes: unreliability in reporting systems, expensive and its time consuming. The developed mobile application was able to address the challenges highlighted.

The second objective was to review existing models, systems architecture and application used currently in identifying and reporting unqualified health practice in health care. This information was useful as it enabled the researcher to gain an understanding of the techniques used and identify the strengths and limitations of each technique hence choosing the best technique to be adopted. This objective was achieved by the review of literature based on the current the current techniques used in reporting unqualified practice. Available technologies include: use of SMS and web based application. Based on the literature review of previous systems the mobile platform emerged to be the best technique for identifying and reporting unqualified practice in health care.

The third objective was to design, develop and test a mobile based application for identifying and reporting unqualified health practitioners and unregulated health clinics. This objective was achieved through the design, implementation and testing of the application. The mobile application was developed and web application using Laravel framework. The following tests were carried out; functional testing where the system functionality was tested, compatibility testing where different Android versions was tested against different Android version and the web application was tested against different web browsers and user testing where the user friendliness, application functionality and user acceptance were tested.

The fourth objective was to validate that the mobile application for identifying and reporting unqualified practitioners solves the existing challenges using the current technology. This objective was achieved using a questionnaire (Appendix B).The respondents were asked to state weather the functionalities provided in the mobile applications were providing solutions to the current challenge of identifying health practitioners and health facility, if they were satisfied with the mobile applications as a solution to their addressed problem and if they had any additional information that the researcher might use to improve the application.

The validation the effectiveness of the solution and was done by users interacting with the application. The compatibility test done on the system also found out how easily the system can function on the different existing platforms. The system met the needs of the users as one of its main goal was to report unqualified health practitioner and unregistered health facilities which was addressed by the report functionality that allows users to make real-time reports. This objective was therefore met with satisfaction from the users as it had addressed the main concerns the user while searching for licenced doctors and health facility.

6.4 Advantages of the Application as Compared to the Current System

One of the advantages of the application in relation to the current verification process of doctors and health facilities is that the mobile application allows users to search and view doctors and hospital profile. The user can be sure that the person treating them is qualified and licenced to operate hence eliminating the quacks practice in health care.

The mobile application allows for users to make real time reports for unqualified health practitioners and unlicensed health facilities. Users can give a brief description of the incident and post in order for them to report the incidence.

The mobile application eliminates the costs incurred by the medical officers to do crackdowns and inspections in search for the quacks and unlicensed clinics. The application has made the process very fast and relatively affordable since all the reports made by the citizens can be viewed by the medical officers without having to move around.

6.5 Limitation of the Application

The android GPS precision while reporting an unlicensed health practitioners and health facility was not very accurate, especially when using the network provider. This is because the network provider location provider uses the cell towers as the location markers for every mobile phone under that network provider. The inaccuracy of the location provider this application used in terms of distance is as far as the user is from the network provider cell tower.

The credibility of the reported unqualified health practitioners or unlicensed health facility was hard to prove since the application is open to the public hence any malicious user can decide to post an inaccurate report. A way to sieve the accurate from inaccurate reports was a challenge while implementing this mobile application. The GPS mobile for the Android platform consumes the phones battery at a high rate. The main challenge in this application as

regards to this is in implementation tracking of the unlicensed practitioners. This module required the user to have his mobile phone GPS module on.

Chapter 7: Conclusions and Recommendations

7.1 Conclusions

The main goal of the dissertation was to develop a mobile application that can be used to identify registered health practitioners and licensed health facilities and report any unqualified practice in health care and hence address the need of users with difficulty in reporting unqualified practitioners and health facility in Kenya. The opportunity that exists in Kenya concerning unqualified practice reporting is not well tapped especially with the increase in the number of smart phones with Android Operating System. The mobile application comes in handy to provide a solution to the way users report quack practitioners and unlicensed health facilities in Kenya. Literature of various health reporting systems was studied and previous research done on the reporting systems. Most of the reporting systems were web Based, SMS platform and mass media channel reporting platform.

The challenges of unqualified health incidence reporting in Kenya was investigated successfully and it was noted that patients visiting this unlicensed health facilities and getting treatment form unqualified health personnel lack a proper platform to search for qualified practitioners and report the ones that are not licenced to operate. The assessment done showed that most victims notify the authorities through media channels, newspapers and physical complains to the hospital facilities. The related designs, architectures and models of health incident reporting was studied and the gaps in the systems identified since most of these models and applications did not give real-time reports thus not very effective as a mobile application that comes in handy.

The proposed solution is an Android based mobile application was designed, developed and tested for use by patients visiting health facilities in Kenya. The solution was gathered and mapped using various diagrams such as use-case diagrams, sequence diagrams, context diagrams and entity relationship diagrams of the database. The application will allow users to search for licenced health practitioners and licenced health facilities and report any unqualified practice in health care. Based on the overall statistics of user testing and evaluation, it is safe to say that the application fulfils its simplicity and usability requirements. Based on the questionnaire responses, the application is generally considered easy to understand and use. The research objectives can thus be said to be achieved because the application had good reception among the target users that participated in the testing process.

7.2 Recommendations

The recommendations that can be drawn from the research are that the authorities and the government of Kenya should recognise and embrace the efforts of mobile applications in trying to improve the status of health practice when it comes to health care in the country. It should also support such efforts through funding and integration of various health systems with the relevant departments and authorities for improved health care status. The search module was considered in complete because users of the system wanted the profile picture of the health practitioner included besides the practitioner's details being displayed to the user. The practitioner's image will help in further identification of the health practitioners. The navigation of the application was recommended for improvements to make it very easy to navigate.

7.3 Suggestion for Future Work

The research findings of this study are not final and therefore there exist room for improvement. This is possible due to the technological advancements taking place constantly which can be incorporated in this research. The following are therefore areas that could be explored for future improvement of the research.

The application can be extended to run on other operating systems such as the IOS based on the user base and mobile device penetration so as to get access to huge audiences. The application will be free to download on Google Play Store but further research needs to be done on how the mobile application can be incorporated in to the relevant authorities such as the Nursing Council Board. The application can be extended to USSD and SMS to the system, this will help to cater for individuals without a smart phone. The mobile applications should be further developed to allow for persistent storage of data capture. This capability will make it possible for user's mobile device to store data when there is no Internet connectivity. Data can then be transmitted to the server and response back to the mobile device immediately an Internet connection is established.

Currently this application shows the static list of doctors available in the particular hospital. This application can be enhanced to provide real time information about the doctor present in particular time in the specific hospital. More functionality should be added to the mobile application to help the users use the application more often. There needs to be more research on how to verify authenticity of the reported health practitioners and licenced health facilities because the reports are just reported by anyone with the application installed on their mobile phone.

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Appendices

Appendix A: System Requirements Questionnaire

Dear Respondent,

I am a Masters student in the Faculty of Information Technology, Strathmore University conducting a research entitled, A Mobile Phone Solution for Systematically Identifying and Reporting Unqualified Practitioners in Healthcare, Kenya.

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

Kind Regards,

Aradi Doreen Viduya.

* Required Fields

SECTION A: BACKGROUND INFORMATION

1. What is your gender? * Mark only one oval.

   - ◯ Male
   - ◯ Female

2. What is your age group? * Mark only one oval.

   - ◯ 13-17
   - ◯ 18-24
   - ◯ 25-34
   - ◯ 35-54
   - ◯ 55+

3. What is your relationship status? * Mark only one oval.

   - ◯ Married
   - ◯ Single
   - ◯ Dating

4. What is your occupation? * Mark only one oval.

- ◯ Employed
- ◯ Student
- ◯ None

SECTION B: TREATMENT INFRORMATION

5. Have you been treated by a fake doctor? *
   Mark only one oval.

   - ◯ YES
   - ◯ NO

6. If YES where was the fake doctor operating from?
   Mark only one oval.

   - ◯ Private Clinic
   - ◯ Public Clinic

7. Did you report the fake doctor? Mark only one oval.

   - ◯ Yes
   - ◯ No

8. How did you report this incidence? * Check all that apply.

   - ☐ Media station
   - ☐ Via Hospital Facility
   - ☐ Via Phone call
   - ☐ Email
   - ☐ Other:

Appendix B: Usability Testing and Validation Questionnaire

Section A: Usability Testing

A1. How do you find the user interface of the mobile application based on its look and feel? (Choose ONE)

- o Attractive
- o Average
- o Not Attractive

A2. Rate the mobile application based on whether the application was easy to learn and use as a first time user? (Choose ONE)

- o Good
- o Fair
- o Bad

A3. Rate the system functionality based on whether it met the user requirements? (Choose ONE)

- o Yes
- o No

A4. Would you use the mobile application in identifying qualified practitioners and licenced health facility in Kenya? (Choose ONE)

- o Yes
- o No

Section B: Validation Testing

B1. Do the functionalities provided by the application solve the problems faced during identifying genuine health practitioner and health facilities? (Choose ONE)*

- o Yes
- o No

B2. Are you satisfied with solution provided by the application as far as identifying and reporting unqualified health practitioners is concerned? (Choose ONE)*

- o Yes
- o No

B3. Would you recommend other citizens to use the application? (Choose ONE)*

- o Yes
- o No

Appendix C: Wireframes

Figure C. 1 Splash Screen Page Wireframe

Figure C.1 represents the wireframe of the splash screen. It is the first screen a user will see once they download the application. It gives a brief description of what the application is about.

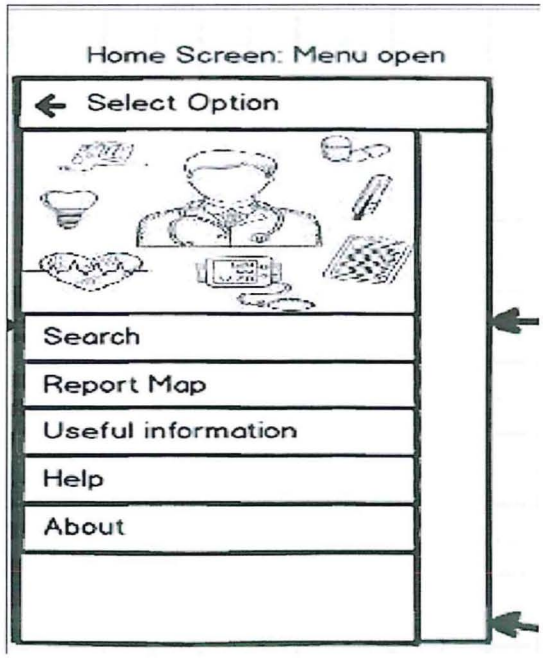

Figure C. 2 Home Page Wireframe

Figure C.2 represents the wireframe of the home page with the menu option of the functionality that the application has.

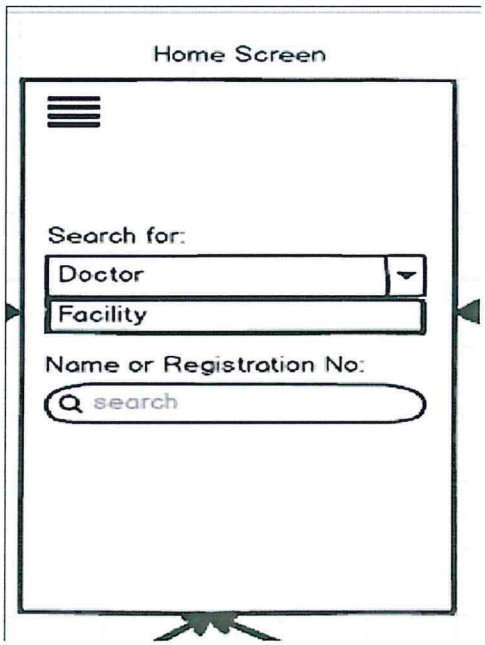

Figure C. 3 Search Page Wireframe

Figure C.3 wireframe is the search screen this screen allows the user to search for a licensed doctor or facilities using the doctors/facility name.

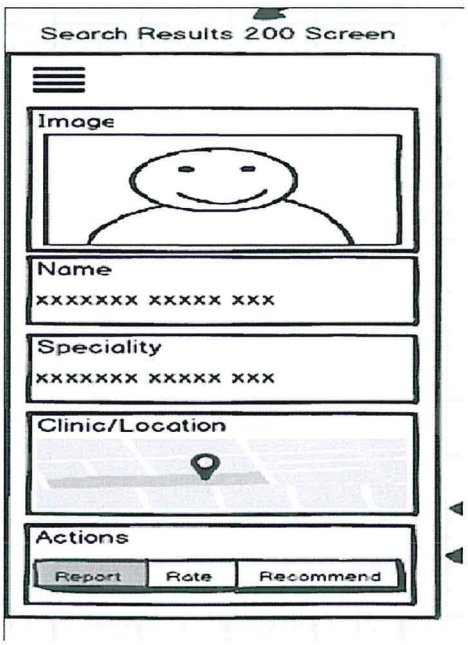

Figure C. 4 Search Result Page Wireframe

Figure C.4 represents the search results page wireframe. When the user inputs the correct details this screen is displayed. The user will be able to see the image, name, specialty and location of the doctor. Below there's is an action bar with report, rate and recommended.

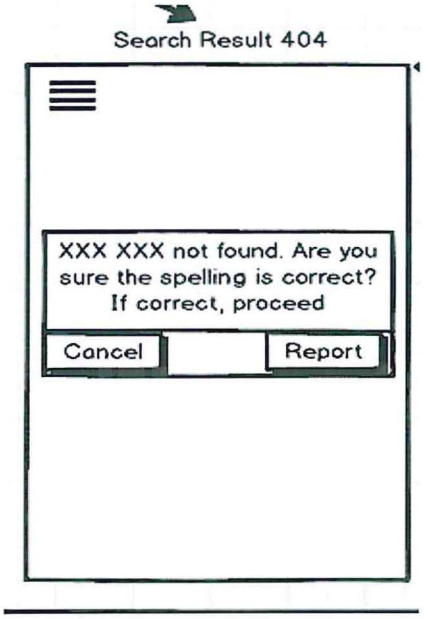

Figure C. 5 Report Screen Wireframe

Unsuccessful screen wireframe. In case a user inputs the correct details but the doctor is not in the list of doctors the user can click on the report button and submit the information of the unregistered doctors or unlicensed clinic. That information will be available on the side of the board for them to take action.

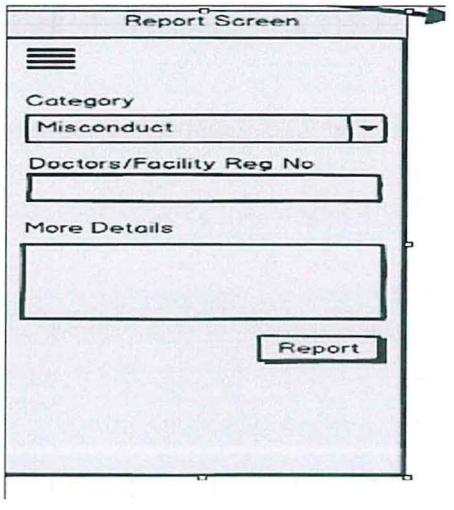

Figure C. 6 Report Details Page Wireframe

Figure C.6 represents the report screen wireframe. The report screen has categories of how to submit an issue. Category is divided into three: misconduct, unlicensed doctor and unlicensed facility. Doctors/facility registration number of the quack and any other details.

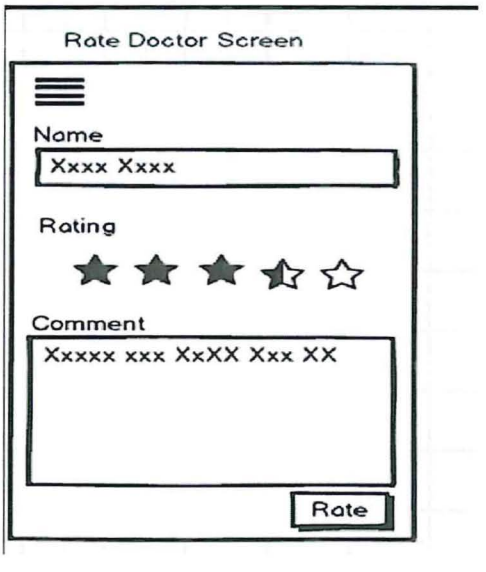

Figure C. 7 Rate Doctor Page Wireframe

Figure C.7 represent the rate screen wireframe. This screen will enable a user to rate the doctor/facility after being offered services.

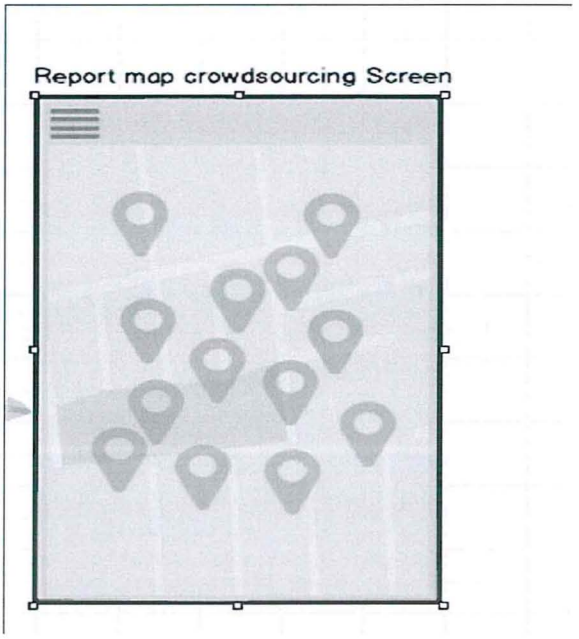

Figure C. 8 Report Map Wireframe

Figure C.8 represents the report map wireframe. This screen will allow the users to view through Google map which areas have been affected by quack doctors/unlicensed facilities.

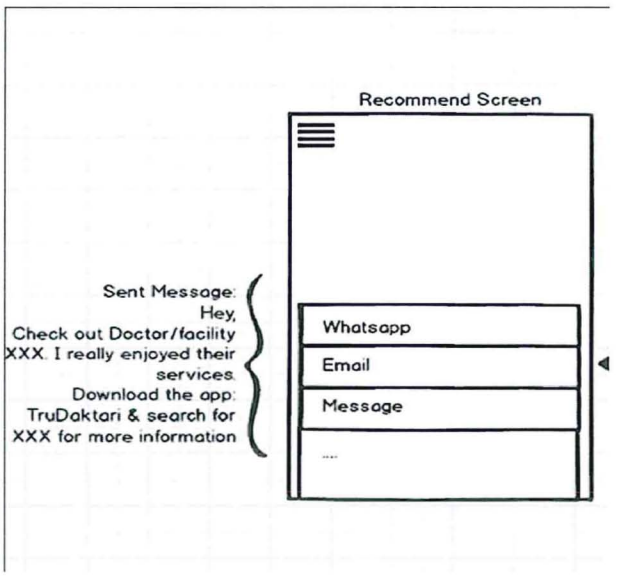

Figure C. 9 Recommend Doctor and Clinic Page Wireframe

Figure C.9 represents the recommend screen wireframe. The user can share doctors' information through other platforms like WhatsApp, email and messages.

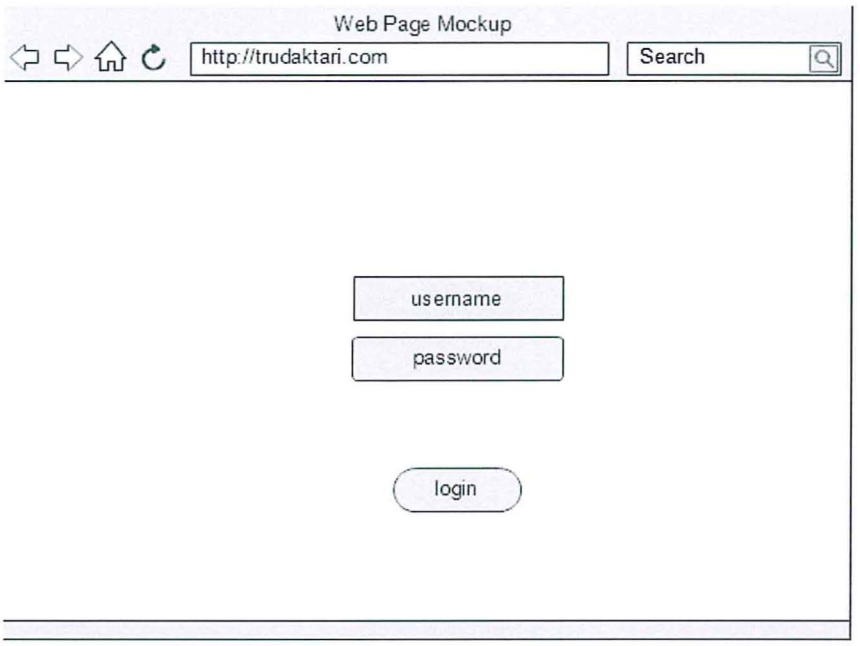

Figure C. 10 Back-end Login Page Wireframe

Figure C.10 is represent the back end login of the application.

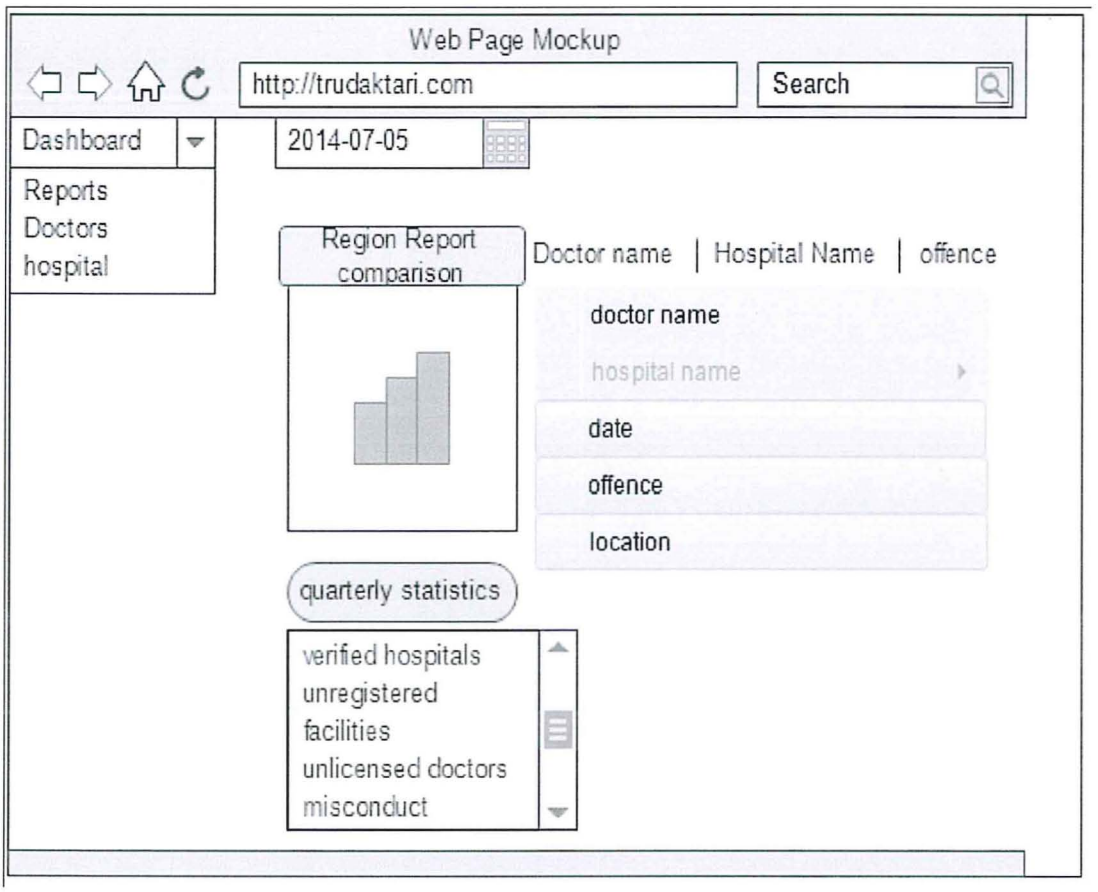

Figure C. 11Dashboard Page Wireframe

Appendix D: Screenshots

i. Splash Screen

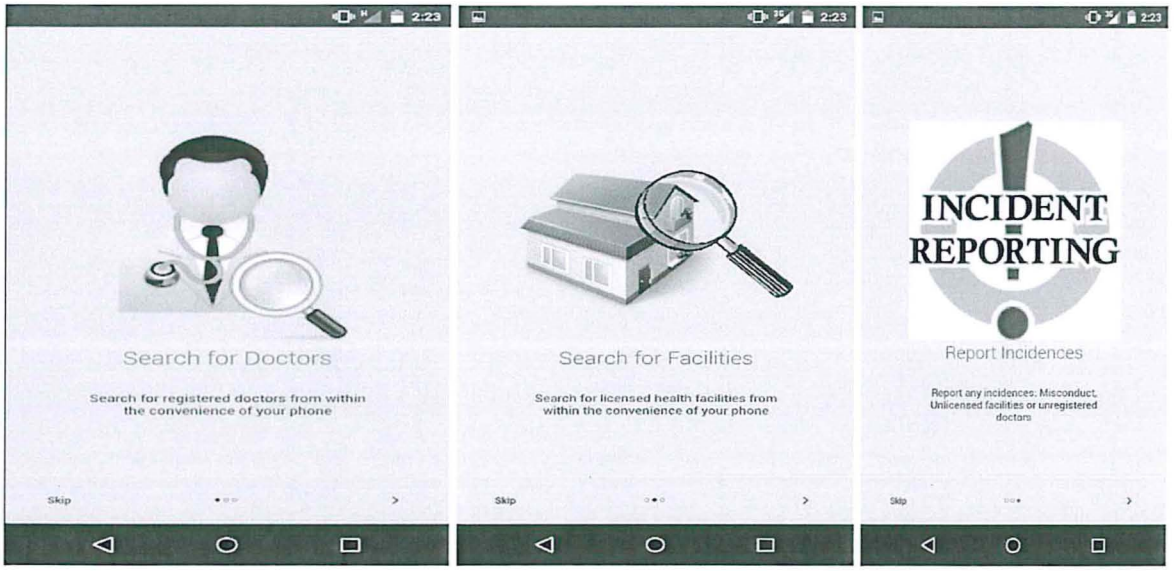

Figure D. 1 Splash Screen

Figure D.1 shows the first page that is displayed when the user installs the application. The splash screen has a brief description of what the application is about.

ii. Home Page

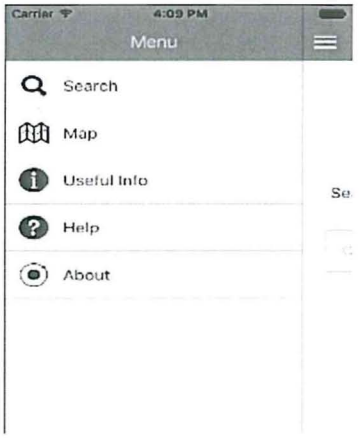

Figure D. 2 Home Screenshot

Figure D.2 shows the menu page that is displayed when the user starts the application. The menu page has list of options that a user can select from.

iii. Search Page

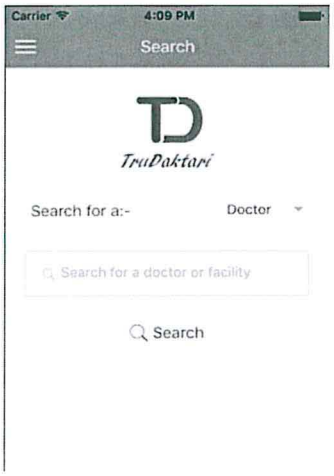

Figure D. 3 Search Screenshot

Figure D.3 shows the search page that is displayed when the user clicks on search. The search page allows the user to select either a doctor or a health facility. The user inputs the name of the doctor and the health facility to enable them to search. iv. Doctors Search Results Page

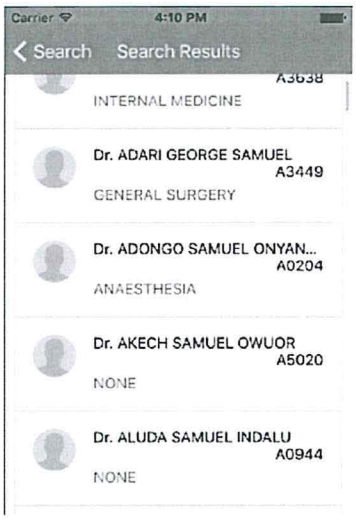

Figure D. 4 Search Results Screenshot

Figure D.4 shows the search results page that is displayed after the user has searched for a doctor. The search results has information on the doctor's profile.

v. Hospital Facility Search Results Page

Figure D. 5 Facility Screenshot

Figure D.5 shows the search results page that is displayed after the user has searched for a hospital facility. The search results has information of hospital profile.

vi. Report Page

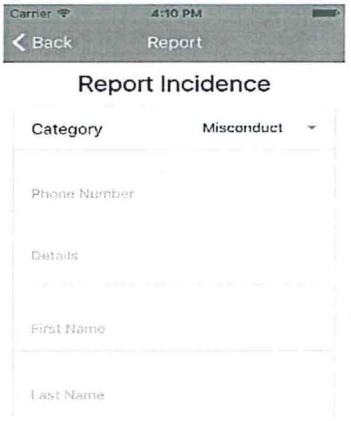

Figure D. 6 Report Screenshot

Figure D.6 shows the report page that allows the user to make a report. The report page has a category list that a user needs to select from. The user can also submit basic information concerning the report and can submit. The report is displayed on a map with markers that indicate reports made by users.

Figure D. 7 Report Map Screenshot

Figure D.7 illustrates the reports made by the users of the application.

vii. Useful Information Page

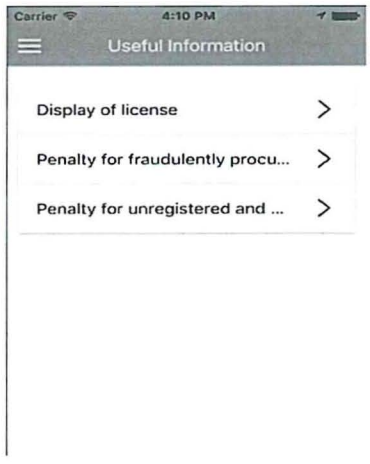

Figure D. 8 Useful Information Screenshot

Figure D.7 shows the report page that allows the user to make a report. The report page has a category list that a user needs to select from. The user can also submit basic information concerning the report and can submit. The report is displayed on a map with markers that indicate reports made by users.

Web Application Screenshots

Viii. Login Page

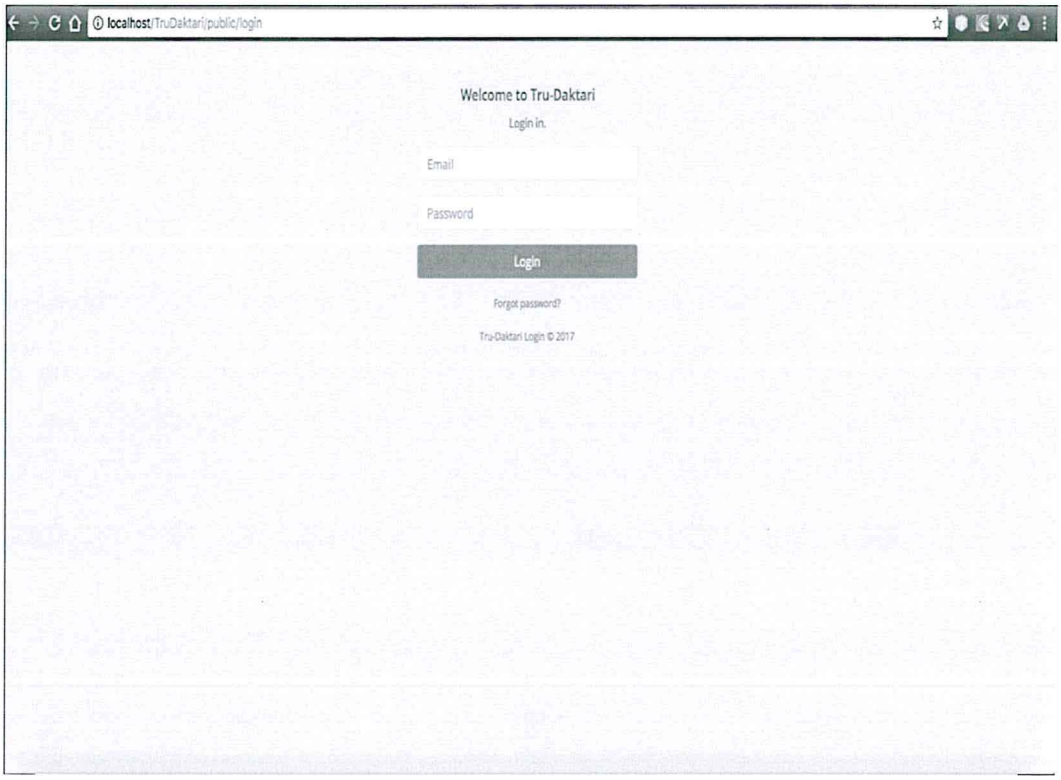

Figure D. 9 Login Page

Figure D.9 shows the login page of the back-end application. The user requires a username and a password.

ix. Dashboard Page

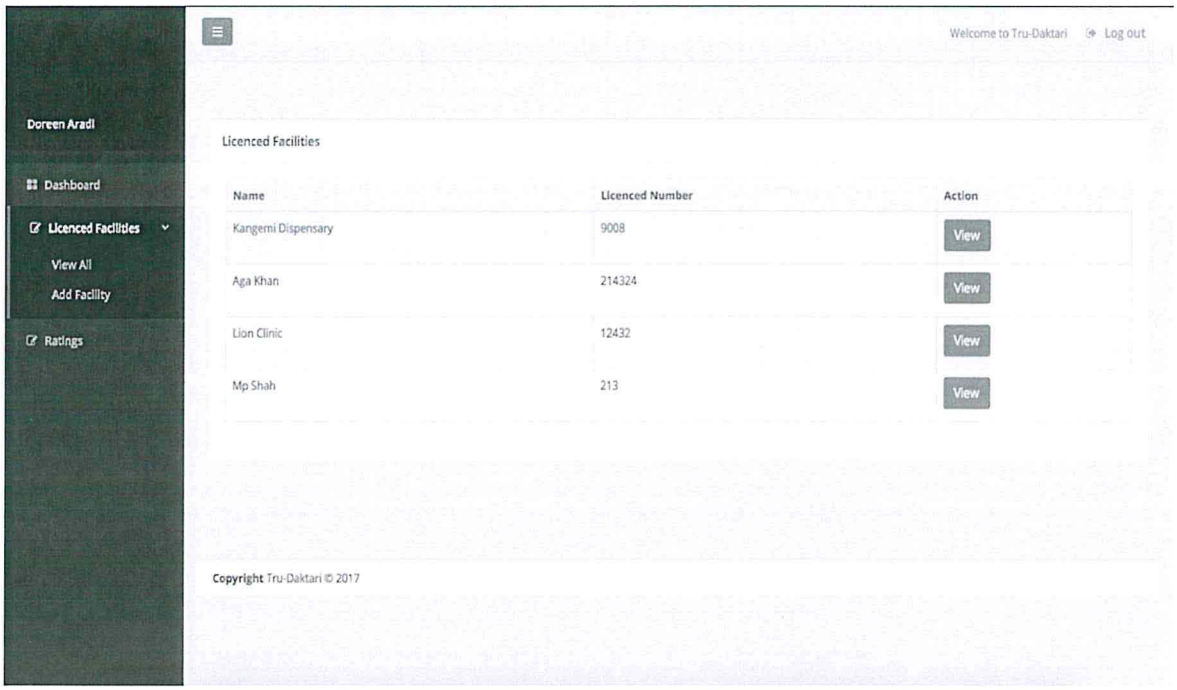

Figure D. 10 Dashboard Page

Figure D.10 shows the dashboard page of the web application. The user is able to view the clinics, ratings and the doctors in the system.

x. Licenced Facilities Page

Figure D. 11 Hospital Facility Page

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