A WEB-BASED HEALTHCARE INFORMATION SYSTEM TO ENHANCE HEALTHCARE DELIVERY IN KIBERA SLUMS, NAIROBI

BY

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DECLARATION

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I declare that this thesis is my original work, except where indicated by special reference in the text. No part of this thesis has been submitted to other institution for any awards.

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DEDICATION

I dedicate this thesis to my Dear Mum

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For errors and/or omissions in this thesis, I solely take full responsibility.

ABSTRACT

Provision of healthcare information services has remained the biggest challenge to realization of universal healthcare in Kenya. The challenges associated with delivery of quality healthcare services to the consumers have been further compounded by the escalating costs of health services and acute shortages of qualified professionals in Kenya. As a result, many parts of the country continue to lack quality healthcare. Until the advent of computer systems people accessed health informationusing traditional media like word of mouth, radio, print media and TV. The introduction of computer systems in delivery of health services could have several advantages to the clients, e.g. improved quality, accessibility and affordability of healthcare services delivered to majority of the consumers. The focus of this study was to determine the information needs of Kibera Slums residents for purpose of designing, developing and deploying a web-based health care information system. This integrated system is referred to as Kibera Health Net. The objectives of the study were: to determine challenges facing access to and delivery of health-related information to residents of Kibera Slums, explore the appropriateness of an ICT solution to these challenges, examine current level of ICT capacity among Kibera Slums residents, and assess healthcare information needs of Kibera Slums residents for use in system requirements analysis, design and development. The literature review covered primary, secondary and tertiary material on the use of ICT-based solutions and mobile phones in delivery of healthcare. The sample for the study comprised a total of 384 respondents drawn from Kibera Slums. They were selected using both cluster sampling and random sampling techniques. Data was collected using the interview schedule method. The findings show that information needs of residents relate to the health problems in the slums. The study established that word of mouth was predominantly used in delivery of health-related information, followed by radio, print media, television, the Internet and mobile phones. However, a growing trend in computer and mobile phone usages by the youth was observed, which also suggested increasing levels of computer and mobile phone adoption among residents. Study concluded that residentsindicated preference for use of the Internet and mobile technology in the delivery of healthcare. Finally, suggestion for further research in the application of ICT-based solutions in delivery of healthcare services was made.

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LIST OF ABBREVIATIONS

AIDS—Acquired Immune Deficiency Syndrome

MDSS—Medical Decision Support System

ES—Expert System

HIV—Human Immune Virus

HTML—Hypertext Markup Language

HTTP—Hypertext Transfer Protocol

Internet—Internetwork

IP—Internet Protocol

KNBS—Kenya National Bureau of Statistics

LAN—Local Area Network

SDLC—System Development Life Cycle

WHIS—Web-based Healthcare Information System

WWW—World Wide Web

CHAPTER: ONE

1.0 Introduction

This chapter presents the background information of the study.

1.1 Background of the Study

Over the years, transmission of healthcare information services remained the biggest challenge to realization of universal healthcarein Kenya. Until the advent of computer-mediated communication systems;Kenyans relied on traditional communication channels such as word of mouth, radio, print media, and TV to access health-related information. These media were lacking in many aspects. Turin(2013) explains that traditional communications media were semi-duplex, lacking instant feedback mechanisms and therefore did not support real time transmission of data or information. More so, they were unreliable and unsuitable for communicating healthcare information which is always is associated with speed and urgency.

The arrival of computing systems and subsequent adoption by the healthcaresectorhas drastically altered the Kenyan healthcare systems. By using computing systems to communicate healthcare information, the government has managed to transform the national healthcare information management systems to meet the ever growing demands for health-related information.

The advantages of the computer system lies in its potential to improve quality of healthcare services, to make healthcare services more affordable to majority of the consumers, and to deliver equitable healthcare services (Turin, 2013). Turin explains that, “the computer system, commonly referred to as information and communication technology (ICT) is an essential enabler of healthcare service delivery”. Turin also views ICT as an agent for reforming healthcare systems, and more importantly as a tool for sharing health-related data and information amongst various shareholders in the health sector.

The use of ICT-based solutions to deliver healthcare services is also known as *e-Health*(Cimino, 2009). This is a new scientific discovery which seeks to ensure better cares for patients living with chronic and lifelong diseases and conditions. ICT-based solutions could be the panacea to many common health challenges facing Kenya, today. While underscoring the importance of e-Health, the Ministry of Medical Services (2010) explains that, ICT enables people in disparate locations to connect to common data points and to access important and much needed health-related information. The Ministry further explains that, sustainable adoption of e-Health programmesstarts with the development of policies on the use and management of ICT-based solutions for healthcare service delivery, integration of relevant policy standards within the national healthcare development plans and buy-in from the healthcare workers. This should be followed by extensively deploying IT infrastructure within the coverage-areas to provide direct linkages for the various stakeholders within the healthcare delivery systems.

In its efforts to rollout sustainable e-Health programmes, the Government of Kenya (GoK)has put in place a number of policy interventions and strategies. These includeamong others, the Standards and Guidelines for Electronic Medical Records (EMR) in Kenya (2010), Strategic Plan for Health Information Systems (HIS)(2009-2014) and Kenya ICT Policy (2006) (Ministry of Medical Services, 2010). The overall goal of these interventions being; to compensate for the shortage of skilled healthcare professionals by harnessing ICT for improved healthcare delivery and to tap into the latent capacity of healthcare consumers to play an active role in the protection and management of their personal health.

Despite current efforts by GoK to improve access to healthcare, high costsand poor access to healthcare information services remain the biggest challenges to accessing quality healthcare services by majority of Kenyans(Turin, 2013). This reality extends to most of the remote rural areas and urban slums in the country where the majority is poor and cannot afford most of the basic healthcare services.

Kibera Slums in Nairobi typifies situation in many areas that do not have access to quality healthcare and health-related information services. This lack of access to basic

healthcare services and health-related information is evident in the pathetic health conditions of most residents of Kibera Slums. The residents' health challenges include poor sanitation, lack of clean drinking water and inadequate healthcare facilities. More so, due to non-availability of health-related information services in the slums, many residents remain ignorant about relevant sources of health-related information needed for purposes of making important decisions on and managing personal health and general wellbeing.

In response to the many perennial health challenges affecting residents of Kibera Slums, this research focused on finding lasting ICT-based solutions to the problems. By rationalizing that, ICT-based solutions such as the Internet could present unlimited potential and possibilities for use in delivery of health-related information services to the consumers, this study sought to provide practical solutions to Kibera's perennial challenges.The study has also situated the health challenges within the context of government healthcare policy and the general tendency to improve quality of healthcare; on one hand, and accessibility of the health services by all, irrespective of location or economic status.

1.2 Study Area

The study was carried out in Kibera Slums. The slum area has a population of approximately 167,000 people and estimated population density of 2000 people per hectare (Ministry of National Planning and Vision 2030, 2010). Located approximately 5 km southwest of Nairobi City, Kibera Slums comprises a number of villages-Kianda, Soweto, Gatwekera, Lindi, Laini Saba, Siranga/Undugu, Makina and Mashimoni among others.

This study focused on Kibera's health challenges which are caused by among other things:heavy pollution from soot, dust, open sewage routes, and the common use of "flying toilets", which contribute to contamination of the slums with human and animal wastes. Besides, combination of poor nutrition, high rates of HIV/AIDS infections, drugs taking, alcoholism and lack of sanitation, often account for many illnesses and even

deaths in the slums. The study also found out that the other health challenges were water borne diseases such as skin diseases, typhoid, diarrhea, dysentery, choleraand worms.

Taking the conditions forming the background to the study into consideration, this study sought to investigate the healthcare information needs of the residents of Kibera Slums with a view to designing and developing a Web-based Healthcare Information System (WHIS). This system was intended to make health-related information services easily accessible and affordable to the residents of Kibera Slums.

1.3 Problem Statement

In the 21st century, knowledge is the key element to improving health. In the same way that people need clean, clear water, they have a right to clean, clear knowledge (http://www.plosmedicine.org/, 2013). According to Sir Muir Gray, Director of the UK's National Health Service (NHS), National Knowledge Service, "Knowledge underpins every medical advance, every intervention, and every clinical decision. However, access to reliable health information for even the most basic health needs remains elusive for much of the world's population".Access to comprehensive, quality health care services is important for the achievement of health equity and for increasing the quality of a healthy life for everyone.

Access to health services means the timely use of personal health services to achieve the best health outcomes. This according to HIFA (2013), requires 3 distinct steps: gaining entry into the health care system, accessing a health care location where needed services are provided and finding a health care provider with whom the patient can communicate and trust

In a place like Kibera Slums where access to quality healthcare remains one single most challenge, residents continue to die from preventable diseases and conditions. The main causes of high mortality rates in the slum area according to Turin(2013)are poor nutrition, high rate of HIV/AIDS infections, and consumption of illicit drugs and lack of proper sanitation. This concurs with a study carried out by Beatley (2000), which found out that, an estimated20% of the 2.2 million Kenyans living with HIV lived inKiberaSlums. While

another study by WHO (2012) identifies other causes of deathsinclude in the slum as: diarrhoea; other major communicable diseases such as measles, malaria and pneumonia; conditions arising in the prenatal period such as prematurity, birth asphyxia, neonatal sepsis and congenital anomalies; deaths caused by other diseases and by injury; cancer, cardiovascular disease and diabetes, and chronic respiratory conditions. However, what strikes most is the fact that, the high rates of morbidity and mortality in the slum areaare caused by diseases and conditions whichcould have been easily prevented or utmost controlled if residents had access to access to reliable sources of healthcare information to use for purposes of decision making on matters of personal health management and general wellbeing.

Given the current health challenges in Kibera Slums and corresponding need for urgent solutions, any initiatives that seek to alleviate the problems should be supported by all Kenyans. The aim of this study was to findlasting solutions to the persistent health problems emanating fromnon-availability of appropriate communication channels to deliver the much needed health-related information services to the consumers inKibera Slums. This is because making relevant healthcare information services widely available and accessible to consumers is much cheaper than providing medications when people are already sick! Besides, a lot of money and other resources would be savedif such resources were directed towards other more deserving activities other than to medication or caring of the sick.

In this study, the argument was that, there were serious problems whose solutionslied in conducting comprehensive investigative research to find out the missing link. Therefore, the purpose of this study wasto investigate the basic health-related information needs of Kibera Slums residents for use in the design and development of a web-based healthcare information system. The system is meant to provide access to structured health-related information to the residents of Kibera Slums. Subsequently, sustained use of the system by the residents would lead to improved quality of healthcare servicesavailable which would in turn lead to better health outcomes and a healthier population.

1.4 Purpose and Objectives

This study was guided by a purpose and set of objectives.

1.4.1 Purpose

The purpose of this study was to determine the basic healthcare information needs of the residents of Kibera Slums with an aim to design a web-based healthcare information system (WHIS).

1.4.2 Study Objectives

The objectives of this study were:

i. Determine challenges facing accessibility and delivery of healthcare information services to residents of Kibera Slums.

ii. Explore the appropriateness of an ICT solution to the health challenges in Kibera.

iii. Assess healthcare information needs of residents of Kibera Slums for use in system requirements analysis, design and development of an ICT-based solution.

iv. Examine current level of ICT capacity among residents of Kibera Slums.

v. Design and develop a web-based healthcare information system prototype for use by residents of Kibera Slums.

1.5 Research Questions

To address the above objectives, the following research questions were formulated:

i. What health-related challenges Kibera Slums residents face due to lack of accessibility and poor delivery of health-related information service?

ii. How can ICT-based solution be used to enhance healthcare delivery to the residentsKibera Slums?

iii. What kinds of computer and related skills do the residents of Kibera Slums have?

iv. How can an ICT-based solution be developed to provide healthcare information?

1.6 Significance and Justification of the Study

The significance and justification of a study define the implication of and rationale for researcher to conductan investigation. In this study, the significance and justifications were as follows:

1.6.1 Significance

The role of healthcare information needs on healthcare deliveryin the world cannot be ignored. The purpose and essence of any healthcare information system is delivery of the right information in the right place, in the right order, at the right time for the right person and at the lowest cost possible. For this to be achieved, the finding of this study was intended to inform the design and development of an integrated web-based healthcare information system for use by residents of Kibera Slums to access healthcare information.

1.6.2 Justification of the Study

The study sought to find solutions to the many health challenges being faced by the residents of Kibera Slum. While at the same time, the findings and recommendations of the study would be used by the government and other stakeholders in the health sector to reform the national healthcare systems in the country.

1.7 Scope and Limitations of the Study

The scope means the area covered by the study. Limitations are those difficulties arising during the execution of the research process which the researcher does not have control over. These are briefly explained below.

1.7.1Scopeof the Study

The study was conducted only within the designated area and focused only on the application of web-based technologies to delivery of healthcare. The researcher collected data from 384 respondents.

1.7.2 Limitations of the Study

The researcher encountered some respondents who were not readily willing to provide information voluntarily for fear of their identity being revealed, becausethey considered some of the information bordered on personal confidentiality and therefore were not comfortable disclosing the same.

Despite this limitation, the researcher invested extra time in rapport building and rephrasing questions to get information from some respondents. The researcher was able to overcome all these limitations and use available data and time to complete the study successfully and achieve the research objectives.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of recent literature on the use of information and communication technology (ICT) and mobile phones in delivery of healthcare services. The review explores previous studies to identify gaps in existing body of literature on the use of ICT-based solutions to address current healthcareproblems. Reviewed sources include text books, journal articles, periodicals, conference proceedings, seminar reports, government documents, theses, dissertations and abstracts all of which covered in varying details the current research topic. The literature review focuses on thetheoretical framework covering the underpinning theory and on the empirical studies on application of ICT-based solutions and mobile phone technologies to healthcare delivery.

2.1 Theoretical Framework

The study adopted system dynamics theory which also informed and provided underpinning for conceptualization and support of the study's conceptual framework. By placing current research in its context, the theory portrays the study area as a social system comprising of different subsystems or components, each of which react in equally different ways.

To clarify how system dynamics works, Williamson (2011) explains that, action or reaction by the system's component is either a positive (+ve) or negative (-ve) feedback. According Williamson, a positive feedback means a reinforcing effect (more produces more; less produces less), whereas a negative feedback means a balancing effect (less results in more; more results in less). This is fundamental in understanding extant interrelationships among various players within a social system and how their actions or reactions also affect behaviours of the system in which they exist.

2.1.1 The System Dynamics

Several different views of what system dynamics exist in many literatures.There are many different definitions of System dynamics. The researcher follows the definition by Mason (2010)who defines System Dynamics as, “the art and science of making inferences by developing increasingly deep an understanding of underlying structure”. But another equally valuable definition is by Sanal (2006) whodefines System Dynamics as, “a framework for seeing interrelationships rather than things separately, i.e. one has to go beyond events to look for patterns of behaviour and interrelationships which are responsible for the behaviour and events”. These patterns of behaviouror interrelationships are result of various system components interacting in certain ways.

Heffernan and Faulkner (2001) and Williams and Harris (2005) have stressed the importance of these patterns of behaviouror interrelationshipsamong the different components within any system. They have also asserted that System Dynamics is a methodology for studying and managing complex feedback systems, as well as a tool to help address complex issues involving delays, feedback, and non-linearities.All systems thinking approaches focus on simplifying reality so we can deal with it more effectively. Using the system dynamics approaches we can model reality, structurally, so as to review it for usefulness and consistency. More so, system dynamics offers us a means to see the ramifications of that simplification through simulation, so we can test our hypotheses or beliefs(Williams & Harris, 2005).

The basic idea of structure(s), according to Albin (2011), is to point out the influence one thing has on another i.e. how things do influence other things to change. Also, System Dynamics employs the concept of a “system” which is, “an organised whole in which parts are related, which generates emergent properties and has some purpose” (Heffernan & Faulkner, 2001). Hierarchically, a system consists of several sub-systems, each of which is complete and independent. As Heffernan and Faulkner further explain, the way in which the elements or variables composing a system may vary over time is referred to as the behaviourof the system.

There are two approaches to system dynamics according toWilliams and Harris (2005) and Albin (2011), namely: the approaches that mapthe dynamic relationships and then use a variety of methods to understand the possible consequences of those relationships or to develop theories about them, and those that simulate the dynamic relationships in order to explore the consequences of different amounts of intervention, timing, delay and feedback.To depict ways systems'behavioursare influenced by interrelationship between the different variables, System Dynamics uses a set of diagrams known as causal loop diagrams.

2.2 Empirical Studies on Application of ICT inHealthcare Delivery

Bringing intelligent healthcare informatics to bearon the dual problems of reducing healthcare costs andimproving quality and outcomes,has over the years been a challenge, even incountries with a reasonably developed technology infrastructure. But, this seems to no longer hold true. Many thingshave changed. For instance, Roberts (2013)makes strong claims that, led by the US, Canada, Japan, UK, Australia and South Africa, many countries have shown increasingly keen interests in the use of ICT-based solutions for provision of healthcare services.ICT-based solutions are increasingly becoming popular tools for communicating healthcare information and for delivery of non-discriminatory healthcare services tothe citizens in different parts of the country.

Kenya has also joined countries that have adopted ICT-based solutions for provision of healthcare services. For instance, the government has already put in place a number of policy interventions and strategies in readiness for major ICT rollout. These include the Standards and Guidelines for Electronic Medical Records (EMR) in Kenya (2010), Strategic Plan for Health Information Systems (HIS)(2009-2014) and Kenya ICT Policy (2006) (Ministry of Medical Services, 2010). Overall goal of these interventions is to compensate for the shortage of skilled healthcare professionals by harnessing ICT for improved healthcare deliveryand to tap into the latent capacity of healthcare consumers to play active roles in protection and management of their personal health and wellbeing.

Application of the computing system for healthcare delivery comes in various forms and involves different technologies, standards, protocols and even procedures. But one unique

thing about all this is that, these technologies are able to work together seamlessly to deliver the final services. The advantages of technologies are many, and their possibilities, unlimited.

In this study, only a few of the technologies so far adopted for use in delivery healthcare, are dealt with in the subsequent sections as follows:

2.2.1 Web-based Healthcare Information Systems

Murugesanet al. (2010) defines a web-based healthcare information system as, "*a collection of various information applications that provides a centralized repository of information related to patients' care across distributed location"*. The information held by the web-based healthcare information system is resident in a database system somewhere, and is only accessible by connecting to the system, e.g. using the Internet infrastructure. Murugesanet al.(2010) also points out thatthis repository represents the patient's history of illness and interactions with care providers by encoding knowledge that can help physicians and other health workers to make informed decisions about patients' conditions, treatment options and wellness activities. This information is meant also for use by the patients themselves and/or their relatives while deciding on the best course of action they need to take regarding certain health issues.

One reason in support of the web-based healthcare information systems is brought forward by Chalasani (2006)who notes thatthese technologies have added new dimensions to the patient's self-awareness by offering the opportunity to improve their participation in managing own health conditions. The result of these interventions is the accompanying improvement on health outcomes and general wellbeing of the patients. Using these technologies, patients can exploit the omnipresence of the Internet to access health-related information right in the comforts of their own homes or workplaces.

There aremany differences in architecture for various types of web applications meant for equally different platforms usages. But one such common architecture associated with the development of web-based information healthcare systems, is the thin-tierclient architecture (Leonard et al., 2010; Dokas, 2010; Power, 2010).

2.2.2 Architecture for Web-based Healthcare Information Systems

Modern types of web-based applications use the thin-tier client architecture. This architecture uses a browser-hosted User Interface (UI) to dynamically generateand send instructions to the client in the form of HTML through a server. Accordingly, the clients of web applications will have to have browsers pre-installed so the application only focuses on feeding the browser with the instructions it can understand and use to build a presentation to the end user(Leonard et al., 2010;Power, 2010). This way, modern Web Applicationsare able to overcome major limitations associated with traditional software developmentmethodologies that heavily relied on Application Programming Interface (API) to accomplish the same feats.

Another important feature of the thin-tier client architecture is the use of three-layer design. This is explained by Leonard et al.(2010) as follows: the three-layer design is an effective approach for the development of robust, easily maintainable systems with multiple user interfaces. Typically,the three-layer application comprises three layers:the data layer-which manages stored data usually in one or more databases; the business logic layer-which implements the rules and procedures of the business processing; and the view layer-which accepts the inputs, formats and displays processing results. A three-layer design is shown in Figure 2.1below:

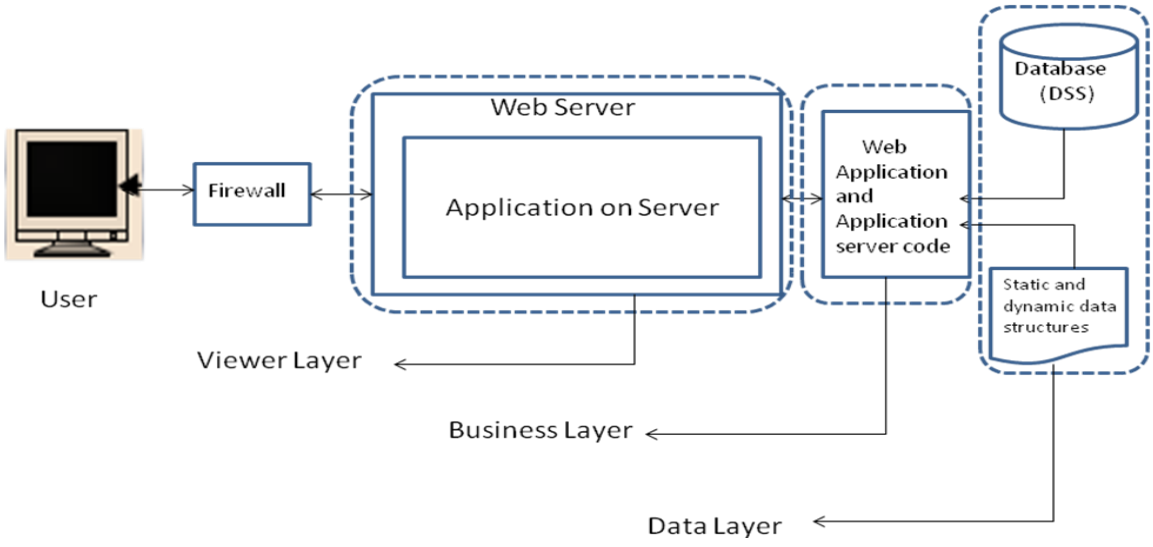


Figure 2.1: The Thin-Tier Client Architecture (Adapted and modified from Dokas, 2010)

Clarifying how the thin-tier client architecture works, Power (2010) explains that:

> *"Requests from users first pass through the firewall server. Simple requests (such as requests for static HTML pages) are handled by the web server, while more complicated requests for the data are handled by the application server. Application server passes the complex requests to the application code. In the databases, the application code is used to retrieve specific user data by formatting and resending requests to the user".*

The most important advantage according to the explanation given by Power, is that, most requests can be handled on the client side and do not have to pass on to the server side. Processing of simple requests becomes a lot faster and does not consume a lot of computer time. But overall advantage of using ICT-based solutions in thehealthcare domain is, Chesalani (2006), is "evident in the exponential growth and applications of such systems to delivery of healthcare services resulting to improved quality of healthcare and general wellbeing of the patients".

2.3 Medical Decision Support System (MDSS)

A medical decision support system contains an expert system which is, *"is a computer system which simulates the knowledge and expertise of a human expert"*(Ribeiro, 2008).These systems are used tosolve real world problems, which under normal circumstances are solved by the domain experts(Murugesan&Srinivasan, 2007). Theexpert system comprises three integral parts, namely: the knowledge base, the database, and the explanation system (interpreter). The components an expert system are shown as follows:

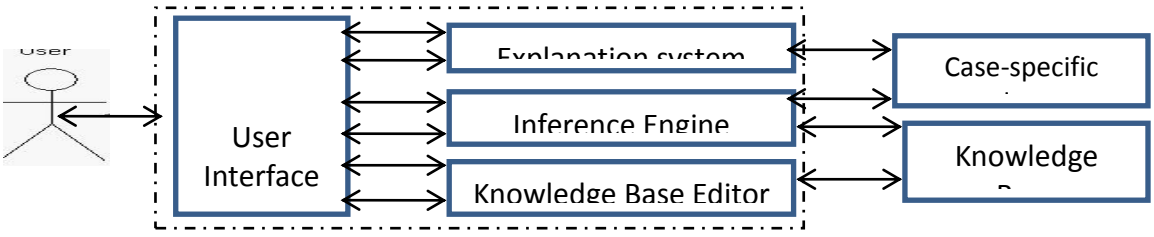


Figure 2.2: The Architecture of anExpert System (Adapted fromRibeiro, 2008)

Therefore, a medical decision support system (MDSS) includes all those computer applications used by medical professionals for medical analyses and diagnoses of clinical conditions (Boreisha&Myronovych, 2010; Ribeiro, 2008). Dr. Robert Hayward of the Centre for Health Evidence defines a medical support system as, *"an active knowledge system, which uses two or more items of patient data to generate case-specific advice"* (Boreisha&Myronovych, 2010). Medical decision support systemsare used to support decision making processes by providing different sets of alternatives which can be used by the decision maker to solve the problem at hand (Ribeiro, 2008).Therefore, the researcher also concurs that, the MDSS are an important means tolink health observations with health knowledge to influence decisions or choices made by the clinicians, and by the patients themselves to enable them effectively monitor and to make informed decisions in the course of managing their health conditions and general wellbeing.

2.4 Mobile Phone Platforms

By no doubt, mobile phone platform is the latest entrant in the application of computer-mediated systems to healthcare delivery. Mobile computing no doubt is going to be the *modus operandi*for transmissionof health-related data and information, in no distance a future. The mobile phone platform is increasingly emerging the leading driver of improved quality, accessibility, safety and cost-effectiveness in healthcare. Many factors have led to this exponential growth of mobile applications and subsequent rapid adoption for real-time delivery of healthcare. Among them, according to Collins (2013) include: the rapid advancements in mobile phone technology such as emergence of new browser applications, expansive telecommunication infrastructures, drastic reduction in cost of thedevices, portability, and interoperability which enables most of these devices to share data and information across different platforms.

The health sector stands to benefit significantly from the real-time delivery of care-something that mobile technology provides efficiently and effectively. Collins (2013) in his recent study on the use of mobile phones in delivery of healthcare in the US, predicts that, "the rapid adoption of smartphones and tablets among clinicians, consumers and employees, and the increasing bring your own device (BYOD) phenomenon are setting

the stage for providers to take steps to revolutionize how they deliver healthcare". Similar studies on the use of mobile phones for delivery of healthcarealso concurred with Collins views (www.searchhealthit.com, 2013).Supported by the present convergence of communications technologies;various communication devices are able to share data and information across different networks. This is evident in the healthcare where patientscan remotely access their medical information, reschedule doctors' appointments, monitor vital signs, receive secure lab results, and manage tailored medication reminders, using their mobile handsets.

The use of mobile phone applications to deliver health serviceshas been referred to as *m-Health*-a term used for the study and practice of medicine and public health that is supported by mobile devices (www.searchhealthit.com, 2013). There are tremendous opportunitiesin the m-Health for streamlining how future health professionals will deliver care to the end consumer. In addition, m-Health has opened the gateway to establishing emergency triage systems; sending medication adherence reminders, enabling home-based antenatal care, tracking community immunization and dispatching mass announcements detailing satellite clinic schedules and locations (Collins, 2013).

In Kenya, mobile-based innovations commonly referred to as m-Doctors, are gaining prominence in some parts of the country as a cost-effective method to address the fundamental problems in our overburdened healthcare systems. This has been for instance; mobile-based systems are being used among HIV/AIDS patients, newly pregnant women and lactating mothers to send reminders on medication adherence, to pre-schedule visits to the prenatal and post-natal care clinics, respectively.

The m-Doctor is a comprehensive, unique and easy to use android app for telemedicine. It enables patients to get medical advice and prescription from various specialist Doctors. Now smartphone could be your doctor. The Doctor can diagnose your disease and give you medical advice as well as prescribe medications via mDoctor. mDoctor allows phone call or Skype video conferencing with doctor from home (https://play.google.com/store/apps/details, 2014). Using mDoctor patients can manage doctors' appointments, medicine and more.

Whichever way the mobile devices are currently used for, mobile health development aims at innovating with the newest technologiesto capitalize on the potential of the latest tablets, smartphones, iPhones, Androids and basic flip phones, which are currently gaining popularity in homes and places of work (Collins, 2013). Also there are distinct mobile computing requirements which the systems must meet depending on different stakeholders'needs.More so, recent advancements in browser capabilities, security, cost reductions and the high availability of cloud computing have made hosted solutions more attractive alternatives to on-premises virtual or appliance mobile computing platforms.

2.5 Perceived Outcomes of using ICT inHealthcare Delivery

Transforming healthcare requires a corresponding transformation in understanding the value that care providers deliver. In allhealthcare systems, the main focus of care providers is to diagnose and treat sick people. Yet, many healthcare systems are reactive and respond only when illness has incurred (Cimino, 2007). Nonetheless, in most cases, the efficacy of an efficient health system lies in its ability to pre-empt and to deliver proactive healthcare targeting people who are most vulnerable and prone to getting infected because of their circumstances.

Recent studies conducted in the US, Canada and the UK, emphasized that ICT-based healthcare systems need to focus on value dimensions such as costs or overall affordability, clinical quality and safety and service quality as well as timely access and choice (Cimino, 2007; Kappel, *et. al.*, 2010; Jones & Lynch, 2011). Roberts (2013) identifies the six dimensions on which an ICT-based healthcare system should be evaluated. These are: safety, effectiveness, patient-centeredness, timeliness, efficiency and equity. WhileLedford (2013) adds that, healthcare systems need to focus on a three-key solution strategy comprising access, quality and value.In support ofabove opinions, the researcher on his part affirms that, "the overall goal of ICT-based interventions in healthcaresystemswould be far more able to meet patient needs and to improve the health of all consumers, irrespective of their socioeconomic status or any other affiliations".

The perceived outcomes of ICT-based interventions in healthcare delivery, according to Ledford (2013)should be better understood when, "these aspirations, taken together, are

best understood by considering their application to individuals in different circumstances: those who are well, at risk, acutely ill, chronically ill, or at the end of life".Ledford further explains how these outcomes are likely to affect different categories of patients by capturing their expectations in the following paragraph:

> *"The "well" are relatively healthy, seeking care only when they feel it is needed, and are less likely to recognize or act on their need for health promotion and preventive services. The "at risk" experience unmet care needs, dissatisfaction with the system, or expectations that go unmet. These are individuals who attempt to access preventive and health-promoting services but who may not receive these services efficiently. The "acutely ill" have time-limited or curable health problems, and typically receive outpatient care for an accident or infection. The "chronically ill" have persistent medical problems, such as diabetes or hypertension, that can be managed but last for months and in many cases cannot be definitively cured. The last population, those "at the end of life," comprise individuals whose proper care is palliative rather than curative*"

This means that, integrating the dimensions of an improved healthcare system across the population will also ensure that patients receive the best quality of care possible. While at the same time, patients can receive timely care through telephone or use the Internet to contact their primary care clinician or other trustworthy sources of knowledge to ask questions, make requests, and receive replies. Nevertheless, one of the greatest challenges to realization of an improved healthcare system is the achievement ofsocial and economic equity.

As researchdemonstrates, socio-economic status, religious and cultural backgrounds often determine the type of care one would be comfortable to receive (Roberts, 2013). For example, low-income earners or people of lower social classare more likely to receive poorer quality care than that received by people who have more income, have higher social status or more education. Paradoxically, the low-income earners are more apt to receive less timely and effective care due to an inability to pay, though less likely to have

a disease like cardiovascular disease, are more likely to die from it.With the existing ICT-based personalized care solutions, patients can now receive the full range of preventive, acute, and chronic services, some of whichhave always been elusive. While, healthcare providers would benefit through increased satisfaction at being able to deliver care that produces greater health and longevity for their patients, and reduces pain and suffering. Sponsors, in turn, would get higher value: more quality and better outcomes for their cash!

2.6 The Conceptual Framework

In the conceptual framework, the use of ICT-based solutions to deliver healthcareis conceptualized within system thinking terms as dealing with behaviours and interactions within a social system. Informed by the System Dynamics, this exploratory model illustrates the constructs of improved communications channels and better management of personal health and general wellbeing. Applicable chiefly to the patient's point of departure and focusing on management of personal health and general wellbeing, the model elucidates those factors that characterize the nature of the relationships between improved communications channels and better healthcare outcomes. As the model indicates,the direct access to healthcare information service will influence the decision making patterns of and choices made by the patient. The success factors in this relationship are: level of patient's satisfaction, achievements of patient's expectations such as long-term or continued enjoyment of better healthcare services as depicted by the model (Figure: 2.4).

Presented in System Dynamics terms, Kibera Slums constitutes a social system comprising: the residents, their cultural beliefs, behaviours, levels of incomes, health problems and other health-related conditions. The main problem that research sought to solvewas,"lack of access to healthcare information services". By conceptualizingKibera Slums as a social system, the model provides a framework for understanding behaviourswithinthe system and the subsystems, more specifically, how the intended system would offer the desired solutions to the health problemsthat have been identified.

In the final analysis, the health problemshave been conceptually presented as gap between "**Current level of Awareness"** and "**Desired level of Awareness"**. Solution to the problems lies in bridging the gap. As has been repeatedly mentioned in this study, the intended systemis meant to provide access to the much needed healthcare information by residents ofKibera Slums. Continued use of the system will lead to "**Desired level of Awareness"** and better management of personal health and general wellbeing, which in turn will lead to "**Desired Health Status"**which is a **"Healthy Population**" as shown in the Conceptual Model provided in Figure 2.4 below:

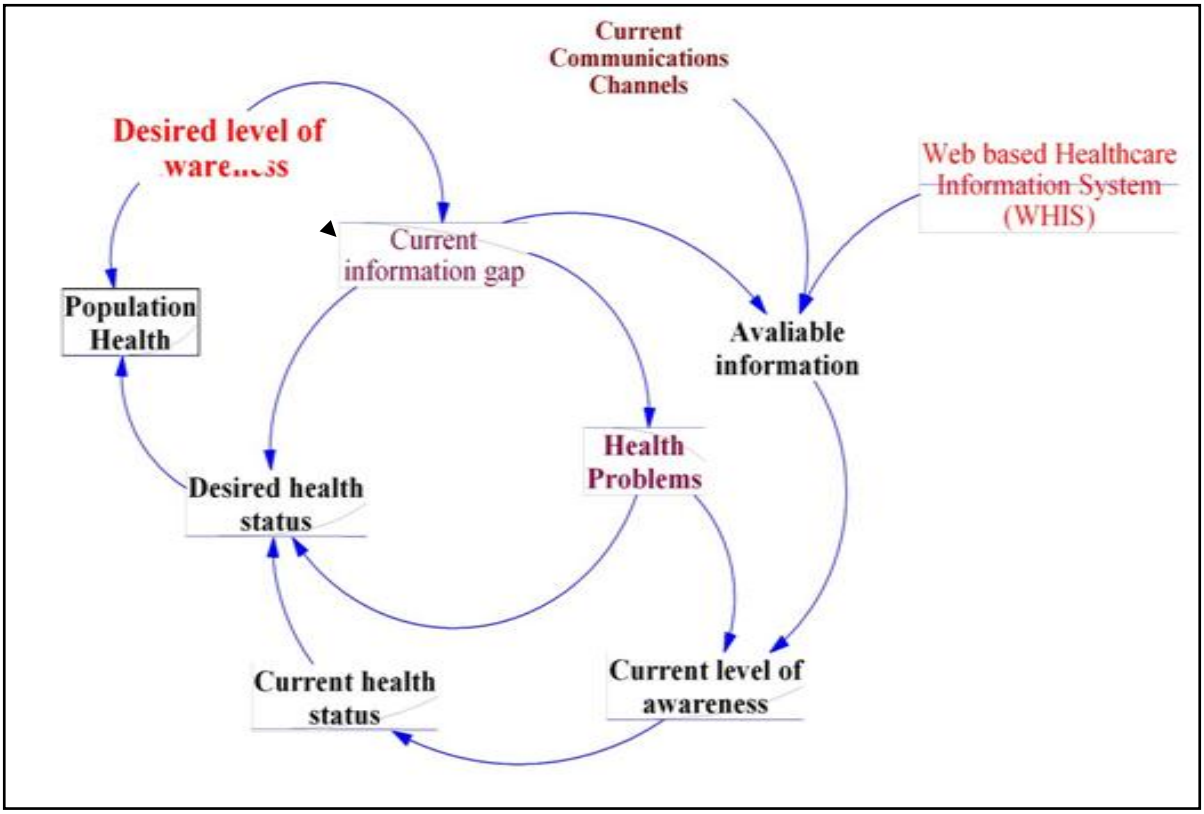


Figure 2.3: The Conceptual Model

In interpreting the abovephenomena in context of the System Dynamics; lack of relevant healthcare information services is dynamically determined by mutual interactions of three components (variables): demand for healthcare information (desired level of awareness), supply of healthcare information services (available information), and current communications. The general trend in information utilization continuum is well depicted by our conceptual model above. Accordingly, the current level of awareness is the direct

result of information available to residents, and which in turn contributes to directly the current health status of the residents.

By making healthcare information available to majority of the residents, the intended system will effectively be bridging the current information gap in delivery of healthcare services. This will directly influence how the residents will participate in management of personal health and general wellbeing, with final outcomes being; improved health conditions, ability to copeand live longer with illnesses with end of life-conditions.

2. 7 Research Gaps

The emphasis on eliciting research gaps as highlighted in literature review publications was a significant departure from other web-based healthcare information system studies, which focused on program and applications descriptions with very little documentation of what does and does not work. Contrary to popular notion, the evidence base for web-based healthcare information system is weak due to lack of recently published material on the subject; this review found that there is a rapidly growing body of literature on the subject. However, the geographic location, scope of the implementation, sample sizes, and methods used do not provide statistically significant results that point to widespread use of these technologies in healthcare industry, more so, in African countries.

CHAPTER THREE
RESEARCH METHODOLOGY

3.0 Introduction

In this chapter the research methodology used in the execution of the study is described. Also describe are the study design, the population and sampling methods, the geographical area where the study was conducted, the data collection instrument and the methods used to test validity and reliability of the interview schedules.

3.1 Research Approach and Design

A qualitative approach was followed. Mack et al. (2005) defines qualitative research as an investigation that seeks to understand a given research problem or topic from the perspectives of the local population it involves. Qualitative research is especially effective in obtaining culturally specific information about the values, opinions, behaviors, and social contexts of particular populations.

The strength of qualitative research is its ability to provide complex textual descriptions of howpeople experience a given research issue. It provides information about the "human" side of anissue – that is, the often contradictory behaviors, beliefs, opinions, emotions, and relationships ofindividuals. Qualitative methods are also effective in identifying intangible factors, such as socialnorms, socioeconomic status, gender roles, ethnicity, and religion, whose role in the research issue may not be readily apparent. When used along with quantitative methods, qualitativeresearch can help us to interpret and better understand the complex reality of a given situationand the implications of quantitative data(Mack et al., 2005).However, in a qualitative research gaining a rich and complex understanding of a specificsocial context or phenomenon typically takes precedence over eliciting data that can be generalizedto other geographical areas or populations.The three most common qualitative methods arein-depth interviews, participant observation, and focus groups.

Acase study design was used. According to Yin (1993) case study research design generally entails intensive descriptive analysis. It is the method of choice when the

phenomenon under study is contemporary and not readily distinguishable from its content. A case study design enables researcher conduct in-depth analysis of the phenomenon under investigation and most suited for studying respondent's attitudes or inclination towards a particular objects or behaviours. In this study the information was collected through the use of interview schedules and personal interviews by the researcher. This design was chosen to meet the purpose of the study, namely to determine the health care information needs of the residents of Kibera Slums win an aim to design a web-based health care information system.

3.2 Target Population

Leedy (1993) observed that nothing comes out at the end of a long and involving study that is any better than the care and the careful selection of the population. A population refers to the group of people or study subjects who are similar in one or more ways and which forms the subject of the study in a particular research. The target population is the population for which representative information is desired (Parrel, et. al., 1973). The study's target population comprised 167, 000 people living in Kibera Slums at the time of the study (Ministry of National Panning and Vision 2030, 2010). The target population was categorized into four clusters namely: residents, health practitioners, ICT professionals and local leaders.

3.3 Sampling Techniques and Procedures

The study usedcluster and random sampling techniques to determine the sample frame andthe respondents.Parrel, et al. (1973) defines a cluster as a method of selecting a sample of distinct groups or clusters, of smaller units (elements).The cluster technique was used because of the need to divide population into homogenous groups with all members of each group having similar characteristics, whereas, the random sampling technique preferred because of equal probability of every member getting into the final sample. These techniques wereappropriate to the desired objectives of the study given that the population was large, diverse and densely distributed. Also, these techniques were effective and efficient in arrivingat homogeneous and adequately representative sample.

The sampling procedures used involved classifying the target population into four non-overlapping groupsas follows: residents, health practitioners, ICT professionals and the local leaders. Each of the group was treated as homogeneous and representative of all members in each respective category. The four groups were also treated as exclusively distinct from each other and shared no common characteristics.

3.4 Sample Sizeand Sampling Criteria

The sample size was determined using the tabledeveloped by The Research Advisor (2006) (See Appendix V). Usingthe values provided in the table; the size of the population was determined from the left most column. Kibera'spopulation is 167,000 according to Ministry of National Panning and Vision 2030 (2010). This figure falls within the sample size of 384 at 95% confidence level and 5% margin of error. Effectively, the distribution of the sample units is providedin the table below as follows:

3.1: The Sample Frame

Respondent Group	Population (N)	Sample Size (n)	Percentage (%)
Residents	700	248	35.43
Health practitioners	68	63	92.6
ICT Professionals	69	63	91.30
Local Leaders	10	10	100
TOTAL	**847**	**384**	**45.34**

The participants included in the sample were selected to meet specific criteria. The residents had to meet the following criteria to be included in the sample.They should:have lived in Kibera Slums for at least 5 years or more, be mentally sound in

order to consent to participation, willing to participate, 16 years or older, of either sex or any ethnic background and able to speak in either English or Swahili.

The health practitioners, ICT professionals and local leaders had to meet the following criteria to be included in the sample.They should:have been involved with the residents on regular basis, familiar and conversant with health challenges in the slums, mentally sound, willing to participate in research, 16 years or older, of either sex or any ethnic background and able to speak in either English or Swahili.

3.5 Data Collection

Normally there are two kinds of data that a researcher uses: primary and secondary. Primary data is gathered, for the first time, for a specific research especially to response to a particular problem, while secondary data is a data which already exists and has been collected for other researches other the one at hand (Zikmund, 2003). In order to find the answers to the research questions in this study, it would be necessary to collect primary data within the frame of reference which is based on the secondary data collected.

3.5.1 Data Collection Instrument

An interview schedule was chosen as data collection instrument. According to Floyd, (2013), an interview schedule is a set of questions that the interviewer asks when interviewing. An interview schedule makes it possible to obtain data to meet specific objectives of the study. The aim of interview schedule is to standardize the interview situation so that interviewers can ask the same questions in the same manner. An interview schedule can either be structured, semi-structured or unstructured (Kasomo, 2008).

In the study, each interview schedule comprised a set of unstructured questions prepared in advance to guide the interviewers duringinterviewing sessions.During the interviewing sessions, the interviewers asked questions or made leading comments to help the respondents give data and information that met the study objectives. The open nature of the unstructured interviews also made it possible for probing by the interviewer to get deeper information.

The interview schedule method was preferred because it is cheap, easy to use, reliable, and more convenient for interviewer compared to other methods of data collection like questionnaire. Because of face-to-face encounter of the interviewer and the respondent, the response rate is always very high-sometimes 100% response rate is achievable. At the same time, note taking or recording of responses as the interview progresses facilitates data analysis since information is readily accessible and/or already classified by the interviewer.

However,the interview schedule has its own share of disadvantages. For instance, note taking may interfere with the communication between the respondent and the interviewer. Sometimes it may become impossible to maintain rapport with the respondent because of interruption when interviewer is taking notes (Mack et al, 2005).

To mitigate the disadvantages of interview schedule, especially, those associated with the note taking and rapport, the researcher and research assistants met and briefly discussed interviewing procedures and how to capture and record the replies for use in later stages of the study such as analysis and interpretations. The interviewees were also briefed on what was required of them during the actual interviewing sessions. This way, the researcher was able to prepare the respondents and to develop rapport with the respondents well in advance.

Three sets of interview schedules were used to collect the data. One was for the health practitioners, one for ICT professionals and the other one for both the residents and local leaders. The interview schedules consisted mostly of open-ended questions, as these provide more diverse detail. The subjects were required to verbally while the interviewer noted down or recorded the responses. The open-ended questions were reinforced by interjections by the interviewer, especially, whenever the response given by the respondents were not very clear or not understandable. One reason for using open-ended questions was that they allow subjects to respond to questions in their own words and provide more detail.

The interviews were conducted in both English and Swahili to enable those who did not understand English to respond in Swahili. They were given the assurance that the answers

would not be able to link their responses to them at the stage of data analysis, therefore ensuring anonymity. The interview schedules consisted of two sections. The first section aimed at gaining demographic data such as age, level of education, number of years lived in Kibera Slums and gender. This information could assist the researcher when interpreting the results, for example, whether or not the respondents would be to understand the objectives the investigation.

The second section aimed at determining the knowledge and views of respondents on the health-related information needs and the health challenges in the slums. Questions assessing knowledge about health-related problems and their causes, sources of health-related information, available communications channels and familiarity with web-solutions to health-related problems were included. Instruction guidelines were provided verbally by the interviewers during the interviews.

3.5.2 Data Collection Procedure

The interviewers personally met with the respondents at places agreed before the material day of the interview as follows: health practitioners-the local health facilities, ICT professionals-cyber cafes and residents and local leaders-social halls and churches. The interviewers met and interviewed the respondents at the designated places. The interviews were conducted in either inEnglish or Swahili with each session lasting on average, 20 minutes. The interviews comprised question and answer sessions with the interviewer reading to the respondent a set of questions and then waiting for the respondent to reply. The interviewer then noted down in a note book or recorded in a tape recorder for purposes of data analysis all the responses by respondents. The data were collected over a period of two days.

3.6 Quality of Data

To ensure high quality and integrity of data, daily briefings were conducted throughout the interviewing period. All the research assistants involved were trained prior to the onset of the survey. These briefings and trainings were meant to reduce likely impinging factors to quality of data such as interview fatigue andtranslation problems. Nonetheless,

the researcher observed that, during the survey, several othersurveyshad been carried out within the village in the recent past. Therefore, this particular survey required maximum cooperation from the respondents. But still, the research assistants reported hostility and disinterestedness from the respondents. The researcher also noted the problem of language barrier;at least one in every three respondents could understand and communicate fluently in English, though most respondentspreferred to respond in Swahili. Lastly, there were high incidences of mistranslation, particularly, among residents compared to other respondent groups.

3.7 Data Analysis Methods

The reason for carrying out data analysis is to establish the relationships between the findings, aim and objectives of the study. However, analysis of qualitative data can be very challenging. According to Mack et al.(2005), the first step in the analysis of qualitative data is transcription of recordings and typing of field notes.Data analysis and presentation is an essential step in both scientific and social science research in ensuring that all relevant data are captured for making comparison and analysis (Bell, 1993).

The data collected were organisedaccording to different themes. The field notes and tapesused by the interviewers during the survey were classified under different themes and then analysed using content analysis technique. For instance, analysis of demographic data was done using a computer programme called Statistical Package for Social Sciences (SPSS). The data were analysed by using descriptive statistics.

Data generated through open-ended questions were also subjected to content analysis and results presented in tables, bar graphs and pie charts.

The data analysis centered on generating both quantitative and qualitative data results which were then used by the researcher to tabulate the findings and to draw the conclusions.

3.8 Pilot Study, Validity and Reliability

Bell (1993) defines validity as, "the extent to which a test or procedure produces similar results under constant conditions on all occasions". Validity, therefore, defines whether an item measures or describes what it is supposed to measure and to describe. However, it can be argued that, an item that is unreliable is also said to lack validity, while much as an item may be reliable, it may not necessarily be valid (Bell, 1993).

To ensure the validity and integrity of data, a pilot survey was conducted prior to the commencement of actual survey to test on the validity of the data collection instruments. The pilot survey covered population different from one the researcher intended to use for main survey. The data collected from the pilot survey was subjected to tests using descriptive statistics. The result of the pilot survey (pre-test) was used to reframe the interview schedules. The average time for interviewing a respondent in English or Swahili was found to be 20 minutes. This indicated that the interview schedules were suited to purpose for which they were intended. Also, these data were dully documented.

3.9 System Development Methodology and Software Development Tools

System design and development was informed by the system requirements and specifications (SRS)document and data collected during the interviews with the respondents. The system development process involved mapping all the SRS into components of the logical design and then logical design to the physical components using the Requirements Traceability Matrix (RTM). Web engineering approach was employed to develop the web-based healthcare information system. Both the Joint Application Development (JAD) and Prototyping techniques were used at different stages in the development process. The Joint Application Development (JAD) and Prototyping techniques fitted well with the Web engineering approach to system development as both techniques favour user involvement during the system development process.

3.9.1 Joint Application Development

IBM first coined the term joint application design (JAD) in 1970 (Davis & Yen, 1998). The key idea to organize a team consisting of major users, managers, and systems

analysts (or information consultants) and to charge that team with quickly determining, in an intensive session, the requirements for a proposed new or replacement information system. Davis and Yen, (1998) define JAD as a technique for quickly determining system requirements in an intensive session attended by a team consisting of major users, managers, and systems analysts.

JAD was employed by the developer at the early stages of the system development process to determine the system requirements. Using JAD, the developer was able to bring together different stakeholders such as potential users, systems analysts, to brainstorm, project managers to brainstorm on various requirements of the system and to constitute various teams who work on the system development project. JAD was also used to create the time frame for the development of the system.

3.9.2 Evolutionary Prototyping

According to Connell and Shafer (1995) Evolutionary Prototyping is a lifecycle model in which the system is deployed in increments so that it can readily be modified in response to ender-user and customer feedback. In prototyping the system concept is developed as the developer moves through the project. The developer begins by developing the most visible aspects of the system.The developer demonstrates that part of the system to the customer and then continues to develop the prototype based on the feedback he receives. The main goal when using Evolutionary Prototyping is to build a prototype in a structured manner and constantly change it to meet the needs of the client. The reason for this is that the Evolutionary prototype is built to form the heart of a new system; it is constantly built on and changed to form the new system as the clients' needs change.

Evolutionaryprototyping technique was employed to achieve JAD both at the initial stage during system conceptualization and at the final stage when the system neared completion. In the last stage of system development process the developer used prototyping to test how the users would interact with a fully functional system at completion.According to Connell and Shafer (1995),prototyping provides less control than the developer needssince; the developer already knows what he wants the system to do for him.

3.10System Development Tools

The developer also employed other tools todevelop different components of the system as follows:

3.10.1 Macromedia Dreamweaver

This application wasused to develop the website, especially, to create individual web pages. The website comprises a collection of web pages coded in HTML also known as the “Hyper base”. The website provides links to other components of the systems such as the on-line database module; personal health assistant module for providing information on management of personal health and web portal that provides links to external health care institutions.

3.10.2 On-line Database Application(Zoho Creator)

This application wasused to develop an on-line database (the application can be accessed from: www.zoho.com). The on-line application is embedded to the web site and provides access to various data relating to healthcare providers, medical specialists among others. (This application is available for limited and non-commercial use e.g. academic upon registration).

3.10.3 SiteInFile Compiler and WebExe(HTML to Exe Application Converters)

These applications wereused to convert the HTML pages into a stand-alone and executable application. (Both applicationscan be downloaded from the Internet for free though they have very limited functionalities). The applications have different but limited capabilities. For instance, SiteInFile has higher parsing capabilities than WeExe and enables access to external links. Whereas WebExe’s “Search” capacity is superior to that of SiteInFile and is able to carry out text searches very high degrees of accuracy. Therefore, the developer decided to use both of them together so that each could compensate the other’s shortcoming.

3.11 Ethical Considerations

The conducting of research requires not only expertise and diligence, but also honesty and integrity. This is done to recognise and protect the rights of human subjects. To render the study ethical, the rights to self-determination, anonymity, confidentiality and informed consent were observed.

Respondents' consent was obtained before they participated in the interviews. Burns and Grove (1993) define informed consent as the prospective subject's agreement to participate voluntarily in a study, which is reached after assimilation of essential information about the study. The subjects were informed of their rights to voluntarily consent or decline to participate, and to withdraw participation at any time without penalty.

Respondents were informed about the purpose of the study, the procedures that would be used to collect the data, and assured that there were no potential risks or costs involved.

Anonymity and confidentiality were maintained throughout the study. Burns and Grove (1993) define anonymity as when subjects cannot be linked, even by the researcher; with his or her individual responses.In this study anonymity was ensured by not asking respondents to disclose their names. When subjects are promised confidentiality it means that the information they provide will not be publicly reported in a way which identifies them (Polit&Hungler, 1995). Confidentiality was maintained by keeping the collected data confidential and not revealing the subjects' identities when reporting or publishing the study (Burns & Grove, 1993). No identifying information was entered onto the questionnaires, and questionnaires were only numbered after data was collected (Polit&Hungler, 1995).

The ethical principle of self-determination was also maintained. Respondents were treated as autonomous agents by informing them about the study and allowing them to voluntarily choose to participate or not.

Lastly, information was provided about the researcher in the event of further questions or complaints.Scientific honesty is regarded as a very important ethical responsibility when

conducting research.Dishonest conduct includes manipulation of design and methods, and retention or manipulation of data. The researcher tried to avoid any form of dishonesty by recording truthfully the answers of those subjects who could not read or write.The researcher observed high degree of objectivity during analysis and interpretation of data. All information sources used in the study were cited and acknowledgedproperly.

CHAPTER FOUR
DATA ANALYSIS, INTERPRETATION AND PRESENTATION

4.0 Introduction

This chapter presents analysis and interpretation of data gathered using the tools discussed in the research methodology. The chapter focuses on analysis, interpretation and discussion of thefindings. The researcher used the Statistical Package for Social Scientists (SPSS) 13.0 for windows to derive the descriptive statistics the demographicdata provided by the respondents. Content analysis was used to identify similar themesfrom the set of notes and recordings made during the interviews with the respondents. Similar themes were then grouped together for purpose of providing qualitative data which presented in the forms of tables, bar charts and pie charts. Each of the diagrams was followed by summarized narratives of the findings. At the same time, attempts were made to make reference to other related information found in different parts of the thesis.

4.1 Response Rates

The study adopted the interview schedule as the main data collection tool. The total number of respondentsinterviewed was 384. The respondents were drawn from four respondent groups namely: residents, health practitioners, ICT professionals and local leaders who at the time of the study resided in Kibera Slums. The response rate was one hundred percent (100%) since all members of the sample population were interviewed. Analysis of the response rates produced the data presented in Table 4.1:

Table 4.1: Distribution of the respondents by sample size and number of responses

Item	Response Group	Sample Size	Response Rate (%)
1.	Residents	248	64.58
2.	Health practitioners	63	16.4**0**
3.	ICT Professionals	63	16.4**0**
4.	LocalLeaders	10	2.6**0**

TOTAL	**384**	**100**

4.2 Respondents Demographic Characteristics

This section provides demographic characteristics of the respondents in the study. It was used as a basis for further analysis of the specific research objectives and the findings using descriptive statistics, frequency tables and percentages. Demographic analysis was performed, since demographic phenomena affect respondents' social and economic behaviour. Therefore, it was paramount to build the analysis of the data from the document analysis and interview schedule in order to establish the distribution of the respondents by age, gender, and number of years resided in Kibera Slums. Analysis of the interview responses produced the data presented in Table 4.2 regarding the demographic characteristics of the respondents.

4.2.1 Responses by Gender, Age and Number of Years lived in Kibera

The study involved participants out of whom, (45%) were male and (55%) were female. When asked to indicate their age, (31.5%) were aged under 29 year (38.9%) were aged between 30 and 44 years; while (29.5%) were aged 45 years and above. Analysis of the respondent's number of years respondents resided in Kibera Slums statistics revealed that, the minimum number of years of the respondents was 1 year with the highest being 5 years. The mean number of years respondents resided in Kibera Slums was 5 years.

Table 4.2: Distribution of Respondents by Gender, Age and Number of Years lived in Kibera

		Table N %
Gender of participant	Male	45%
	Female	55%
	Total	**100.0%**
Age of participant	Under 29years	31.5%
	30-44 years	38.9%
	45 years and above	29.5%
	Total	**100.0%**
Number of years resided in Kibera Slums	Under 1years	20%
	1-2 years	30%
	5 years and above	50%
	Total	**100.0%**

Most of the respondents said they had lived in Kibera Slums for a period ranging from one year to five years. Gender disparity was 45% male and 55% female. They were between 20 and 50 years of age. As such, all of them were very conversant with the health challenges facing the residents as a result of lack of access to relevant healthcare information services.

4.3 Health-related challenges facing residents of Kibera Slums

The health-related challenges in Kibera Slums that are caused by ignorance and lack of access to health-related information services was identified from interactive as one of the factors affecting healthcare information needs of the residents of Kibera Slums. The researcher therefore sought to establish what constitutes health-related problems and the impact of health-related challenges due to ignorance and lack of access to health-related information services on the residents of Kibera Slums. The respondents indicated that the residents are actually facing serious health problems due to lack of access to relevant and timely health-related information they need in order to make effective decisions about their health. The respondents also identified some of the most common causes of health-

related problems among the residents of Kibera Slums. These problems can be broadly classified as follows:

Table 4.3: Distribution of responses on health-related problems in Kibera Slums

Health Problems	Residents	Health Practitioners	ICT professionals	Opinion Leaders
Water borne and contaminated food	✓	✓	✓	✓
Malnutrition		✓		
Drug/alcohol related	✓	✓	✓	✓
Child mortality	✓	✓	✓	✓
HIV/AIDS	✓	✓	✓	✓
Injuries related	✓	✓	✓	✓
Psychological		✓		
Others		✓		

From Table 4.3 above, respondents were unanimous that the common health-related problems arise from taking contaminated water and food, drugs or alcohol, injuries, HIV/AIDS infections and child mortality. However, only a few of the respondents indicated that the problems could have been caused by either lack of proper diets or psychosocial factors. Yet another small fraction of the respondents (mainly health practitioners) pointed out that some of the health-related problems were hereditary.

4.4 Direct causes of health-related problems in Kibera

The study sought to determine direct cause of health-related problems in Kibera Slums. This information was essential in order to investigate healthcare information needs of the residents of Kibera Slums hence are crucial for designing a web-based healthcare information system. The respondents were asked to identify factors which are directly responsible for these problems. The responses were as shown in Table 4.4 below:

Table 4.4: Distribution of responses on causes of health-related problems in Kibera Slums

Causes of Health Problems	Number of Responses	Percentage (%)
High incidences of poverty	288	75
Lack of awareness	384	100
Beliefs and cultural practices	250	65
Irresponsible sexual behaviours	192	50
Drugs taking and alcoholism	81	25
Malnutrition problems	134	35
Structural problems	69	18

The respondents said that most of the problems are caused by lack of awareness as a result of high levels of ignorance and illiteracy among the residents (100%). In addition to ignorance and illiteracy, the respondents indicated other causes as: high incidences of poverty among residents resulting to low income (75%), cultural beliefs and practices (65%), unbecoming sexual behaviours (50%), malnutrition (35%), drug taking and alcoholism (25%)and structures (18%).

According to one of the area leaders, the government is to blame for the problems affecting the people living in the slums in general and Kibera in particular. This particular respondent intimated that, *"every citizen is entitled to clean water, food, proper housing (shelter) and clean environment (sanitation) because they are all tax payers"*. What this particular respondent actually meant was that some of the problems are the result of the underlying government structures such certain policies that tend to discriminate other sectors of the society in terms resource allocations. That is why some parts of the country have better amenities like road, hospitals, and schools water among others.

4.5 Problems dueinadequate of health-related information services

The study sought to determine the problems caused by lack of access to relevant sources of healthcare information services. Respondents were asked to identify the problems that

are directly associated with lack of access to relevant sources of healthcare information services. Table 4.5 presents their responses.

Table 4.5: Distribution of responses on problems due inadequate health-related information services

Problems related to accessibility of health-related information	No. of responses	Percent
Unavailability of relevant sources of health-related information sources	384	100
Inadequacy of the available health-related information	288	75
Lack of awareness about sources of health-related informationavailable	269	70
Communications barriers (Language and technological)	154	40
High incidences of illiteracy	134	35

As shown from the Table 4.5 above, all respondents (100%) reported that the unavailability of relevant sources of health-related information services are directly associated with lack of access to relevant sources of healthcare information, (75%) identified inadequacy of the available health-related information, (70%) reported that communications barriers as the most serious problems affecting accessibility of health-related information by the residents. (40%) made mentioned lack of awareness about available sources of health-related information while (35%) of the respondents identified illiteracy as the causes of health-related challenges in Kibera Slums.

These results imply that in terms of what to expect as far as the problems directly associated with lack of access to relevant sources of health-related are concerned by the residents of Kibera Slums, unavailability of relevant sources of health-related information services, inadequacy of the available health-related information and communications barriers as the most serious problems affecting accessibility of health-related information by the residents. Among the problems least directly associated with lack of access to relevant sources of health-related are lacks of awareness about available sources of health-related information and illiteracy as the causes of health-related challenges in Kibera Slums.

4.6 Information and Communications channels used in Kibera Slums

The researcher found it necessary to establish information and communication channels used by the residents of Kibera Slums to access health-related information. This will enable the maximization information management and utilization of information communication technology in relationship with national healthcare issues and policy. A range of ICT channels was identified by respondents from the list of communication channels used to access health-related information. The results are tabulated below in Figure 4.1.

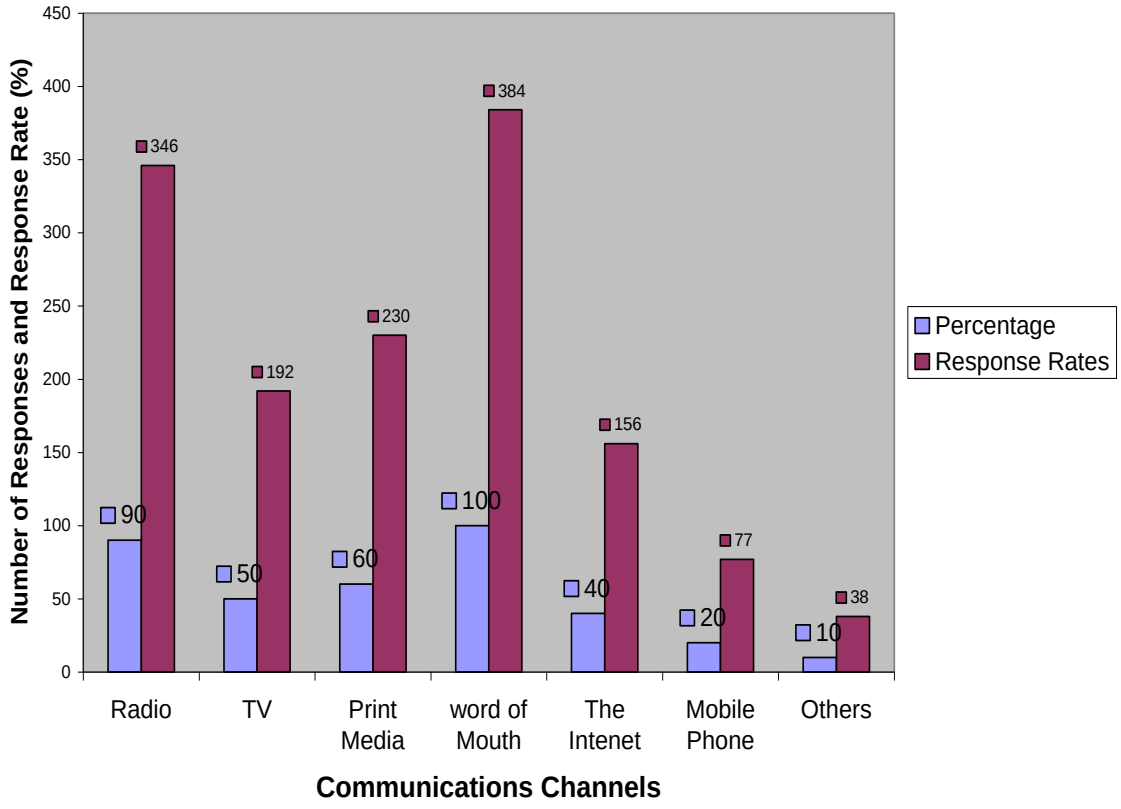


Figure 4.1: Distribution of responses on communications channels in Kibera Slums

From the Figure 4.1 above, 100% of the respondents cited word of mouth, 90% radio, 60% print media, 50% television, 40% the Internet, 20% mobile phone while 10% indicated unspecified channels as being used for disseminating health-related information to the residents. These results imply that word of mouth and radio are the most common

form of information and communication channels used by the residents of Kibera Slums to access health-related information

4.7 Effectiveness of current information and communication channels

To determine the effectiveness of current communication channels used for the dissemination of health-related information in Kibera Slums, the respondents were asked to state how they rate each of the communication channels currently accessible to the residents of Kibera Slums. The results were as shown in Tables 5.6 below:

Table 4.6: Distribution of responses on effectiveness of current communication channels

Effectiveness	Communications Channels (Percentage)					
	Radio	**Television**	**Print Media**	**Word of Mouth**	**The Internet**	**Mobile Phone**
Very Effective	25	10	15	20	55	40
Effective	35	25	35	30	35	25
Fairly Effective	30	35	40	40	5	20
Not Effective at all	5	20	10	10	5	15
Don't know	5	10	0	0	0	0

Analysis of the responses shown in Table 4.6 above indicate that 55% of the respondents were strongly in favour of the Internet and related technologies in disseminating health-related information services. The rest of the responses were as follows: 40% were in favour of mobile phones, 25% radio, 20% word of mouth, 15% print media and 10% television, respectively.

4.8 Prevalence of Cyber cafes in Kibera Slums

The study sought to determine the number of cyber cafes available within Kibera Slums, each respondent was required to provide information on the number of cyber cafés in their immediate neighbourhood, who own them and how long they have been in operation. The responses were tabulated Table 4.7 below.

Table 4.7: Distribution of the number of cyber cafés in Kibera Slums since 2006

Owned by	Number Cyber Cafés	ANCPC	Duration (Years)
Private Individuals	50	3	5
Local NGO (CBO)	10	5	3
Church or Church Organisation	20	7	2
Others	20	3	1

ANCPC*= Average number of computers per cyber café

From the analysis of the results presented in Table 4.7; a number of observations about the availability of cyber cafes in Kibera Slums emerged. Most of the cyber cafes in the village are owned by private entities. However, there was conspicuous lack of government's participation in the provision of communication infrastructures to the people living in the slum areas in general and particularly to the residents of Kibera Slums. This exception is explained by the absence of government owned communications facilities within the village. While it could be argued that the government does not necessarily get involved directly in the implantation of cyber cafes, however, it is the government's responsibility to provide the relevant infrastructures to support such initiatives.

4.9 Familiarity and suitability of ICT-based solutions

In order to determine the level of familiarity with web-based healthcare information system among the respondents, the respondents were asked to state whether or not they

were familiar with or had used any web-based healthcare information systems. Figure 4.2 below presents the distribution of the responses from the respondents.

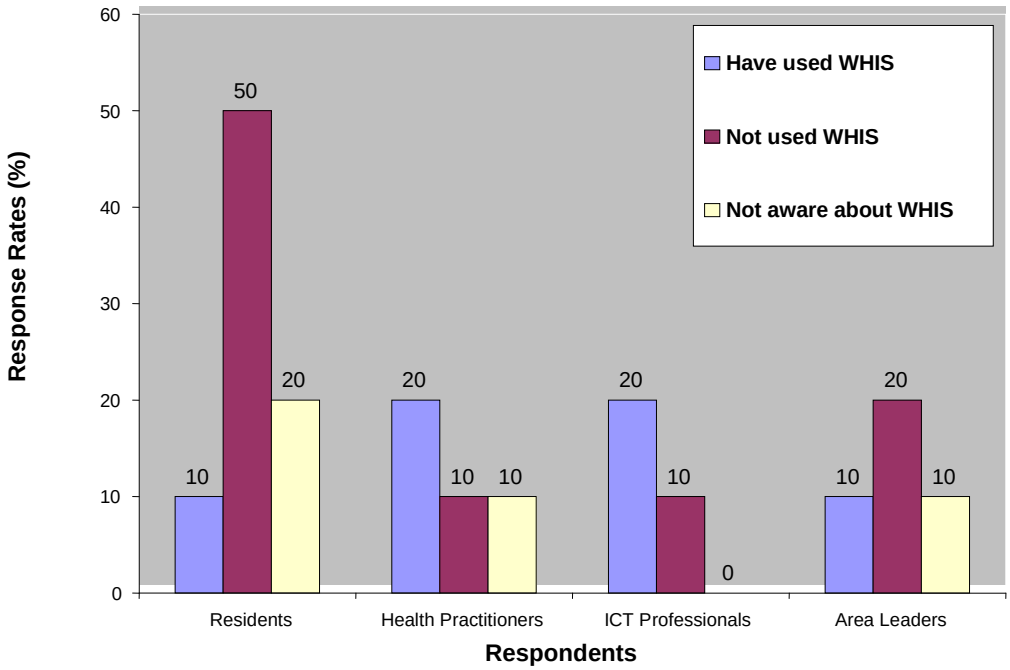


Figure 4.2: Responses on the familiarity with WHIS

From the analysis of the results presented in Figure 4.2 only 30% of the respondents indicated that they were familiar with and have used web based healthcare information systems, while 50% indicated lack of familiarity with web-based healthcare information systems and 20% said that they do not know about such systems. These results imply that majority of the respondents are not familiar with web-based healthcare information systems to access health-related information.

4.10 Chapter Summary

Several conclusions were drawn from interviews with the respondents and participant observations.Going by this evidence, all the issues that emerged relate directly to the problem under investigation. Analysis and interpretation of the data and information collected have also revealed that several factors have, in one way or another, contributed to the health-related challenges in Kibera Slums. However, one singular factor

responsible for most of the health-related problems in Kibera Slums is lack access to health-related information services and its consequent non-availability of relevant communication channels for use delivery of reliable health-related information services to residents of Kibera Slums.

Applying the study's conceptual model to the problem under investigation, it is useful to think of lack of access to relevant health-related information as the most significant contributing factor to health-related challenges in Kibera Slums. From a System dynamics perspective, lack of relevant healthcare information services in Kibera Slums is dynamically determined by the mutual interaction of three components: the demand for healthcare information (desired level of awareness), the supply of healthcare information services (available information), and current communications channels. This means that, the current level of awareness is the direct result of inadequate information available to the residents, which in turn contributes to their current health status.

With additional health-related information available, residents will also have access to more relevant information which in turn will result to increased level of knowledge and awareness, leading to change in personal health status and general wellbeing. Further, this confirms the need for alternative channels for communicating health-related information to the residents in which case an ICT-based solution will go a long way in bridging the current gap in the delivery of health-related information to the residents of Kibera Slums.

CHAPTER FIVE
SYSTEM MODELING AND IMPLEMENTATION

5.0 Introduction

This chapter provides procedures used to design and develop the intended system. The rationale behind the development of this system is to enhance delivery of healthcare information to residents of Kibera Slums and to impact on the way they manage personal health and make decisions concerning general wellbeing. The system will provide access to medical data and general information on management of personal health. More specifically, users will be able to use the system to conduct on-line self-diagnoses, receive feedback on likely medical conditions, and find information on recommended treatments and how to get further help from medical specialists. The system is known as ***Kibera Health Net (KHN)***and its URL will be: http://www.kiberahealthnet.net .

5.1 Introduction

Kibera Health Net is an integrated system intended to provide a single access point to healthcare information services to residents of Kibera Slums. The system comprises a website, an on-line database and a decision support system. KHN integrates data from multiple sources to provide information stakeholders need to make important health-related decision.

At a basic conceptual level, the system comprises a hyper-base-interlinked web pages and forms collectively referred to as a web site. The contents of each web page however unique, builds on to the contents of the other pages to form one seamless web application. The forms provide access to the databases which track the relationships between the entities: hospitals, doctors, care providers (insurance).

The systems administrator, patients and their relatives, doctors, nurses, community based health workers, and care providers (insurance) are the primary users of system. Users of the systems will able to perform the following tasks:

1. Search health-related information on-line
2. Make appointments with doctors on-line
3. Locate healthcare facilities
4. View medical history on-line
5. Contact other stakeholders
6. Search health facilities (hospitals)
7. Search for information about care providers
8. Create new activity, account, object, and person records (as needed)
9. Monitor system's activities and updates the system accordingly
10. Modify the system's parameters as may be necessary
11. Communicate with other users through emails
12. Keep records of all users (administrator)
13. Liaise with other stakeholders for smooth operation of the system (administrator)
14. Set up policies and procedures for use of the system by stakeholders and beneficiaries (administrator)
15. Plan future up-grading of the system (administrator)
16. Engage in on-line chat forums etc.

The web-based nature of the Healthcare Information System (HIS) is intended to simplify or eliminate a number of the tasks performed by the system users, explicitly or implicitly. However, users will be able to perform more tasks that those listed in the outline above, especially, the administrator to enable smoother operation of the system.

5.2 System Development Process

System design and development was informed by the System Requirements and Specifications (SRS) document (Appendix I) and the data collected during the interviews with the respondents. Web engineering methodology was employed to develop system. The development process basically, involved developing two sub-projects and then

merging to form one larger integrated system comprising a website and decision support system.

5.3 System Development Life-cycle

The following is the system development life cycle for Kibera Health Net. It depicts the different stages involved in the development process. The arrows indicate iterative movements from one stage of the development process to the other.

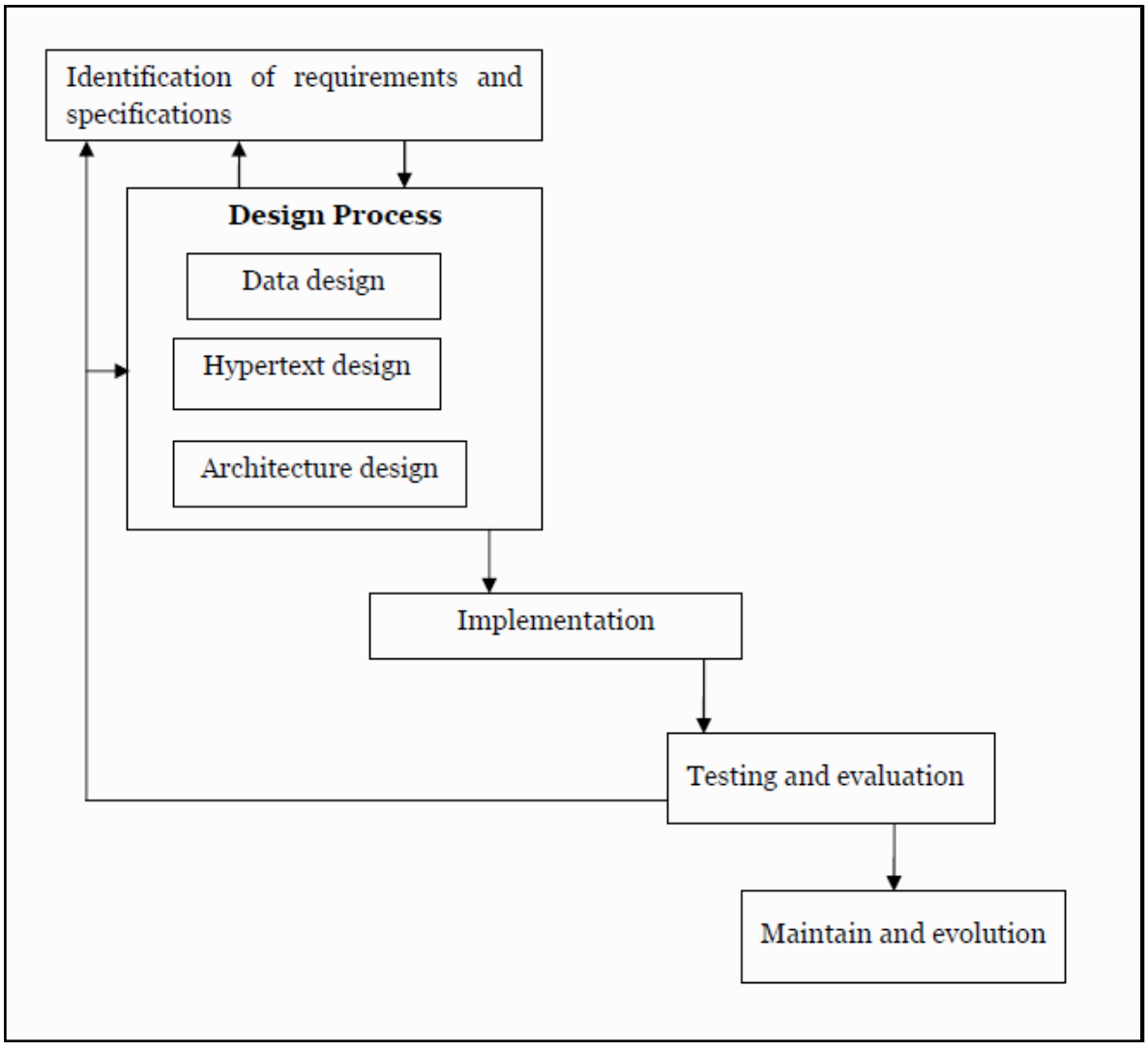


Figure 5.1: System Development Life-cycle (Adapted from Ribeiro, 2008, with slight modification by Researcher)

5.4 System Deployment Diagram

The deployment diagram shows the physical layout of the system. Each component of the system lies on exactly one node as shown in Figure 5.2 below. The external communications components are omitted for clarity reasons.

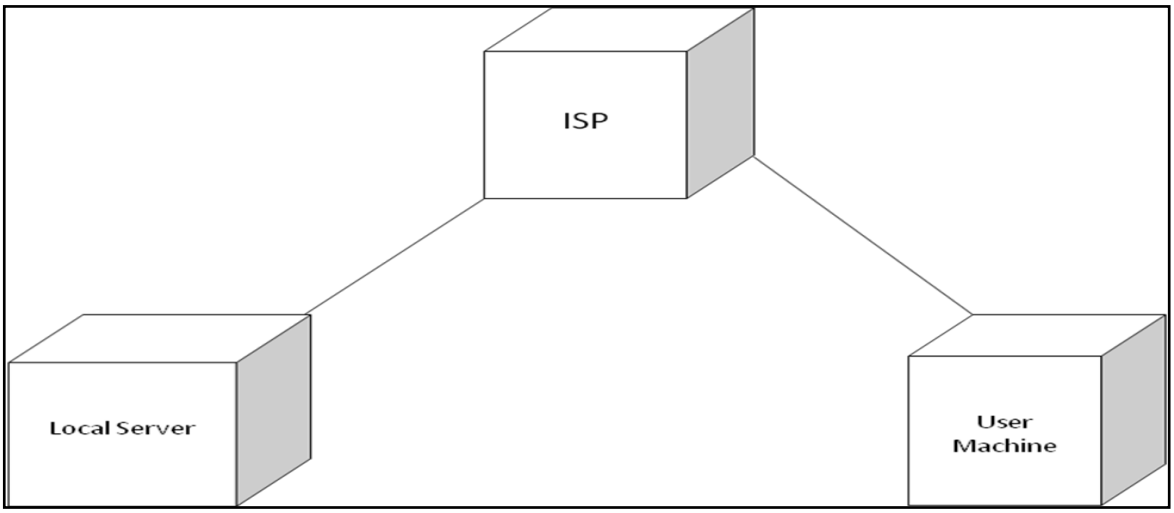


Figure 5.2: System Deployment Diagram

The local server houses the Website, database, expert system and configuration data. The Website and the database are hosted by the Internet Services Provider (ISP) which also provides a logical link between the System Server and the User Machine.

Users interact with the system by sending requests to and receiving responses from ISP through the User Machine.

5.5 Requirements Traceability Matrix (RTM)

The purpose of Requirements Traceability Matrix (RTM) is to maintain the linkage from the source of each requirement through its decomposition to implementation and verification. A developer uses RTM to check if all project requirements have been met, create the various deliverables and guide the project development tasks. RTM therefore ensures that all requirements are addressed, and that only what is required is developed. RTM is also useful when conducting impact assessments of requirements, design or other configured item changes.

The Requirements Traceability Matrix (RTM) for *Kibera Health Net (KHN)* provides the linkages between the approved system requirements, design specifications, and test cases. This RTM was created by associating requirements with their respective work products. Generally, the RTM is a representation of how the system requirements specifications map into system components of the system being developed.

5.6 RTM Development Methodology

The creation of KHN's Requirements Traceability Matrix involved the following steps:

- Identification of user requirements
- Identification of system components
- Mapping of system components to user requirements

5.6.1 Identification of User Requirements

The first step in the creation of a Requirements Traceability Matrix was the identification of user requirements. A list of user requirements was generated from the SRS document. User requirements were then grouped into two broad categories: namely system (Machine) and user (Human). This is shown in Table 5.1 below:

Table 5.1: User Requirements

Requirements	**System (Machine) (RU2)**	**User (Human) (RU1)**
Collect and Store data	X	
Search data	X	X
Manage data	X	
Database Administration	X	X
Perform Diagnosis Tests		X
Data Viewing		X
Synchronous collaboration	X	
Asynchronous collaboration	X	X
Simulation codes	X	
Repository Curation	X	
Access to high performance	X	X

computing resources		
Security	X	X
Safety	X	X
Usability	X	X
Network	X	X
System capacity	X	

5.6.2 Identification of System Components

The second step in the creation of the RTM was the identification of system components. The SRS document served as a source of input data to the identification of system components which are listed below:

Collaboration Tools	Link structure
Data repository (Databases)	Data acquisition
Data viewer	Diagnosis System
Data streamer	Simulation repository

5.6.3 Mapping of System Components into User Requirements

Finally, system components were mapped to one or more user requirement(s). The developer conducted assessment of the system components to determine as to whether the component indicated addresses particular user requirements. This was followed by brief description of deliverable(s) that result from the work performed by the system integrator to fulfill the user requirement.

Table 5.2: Requirement Traceability Matrix forKiberaHealth Net

Req. ID	Requirement Type	Requirement Description	Trace from User Requirement/ Trace to System Requirement	Trace to Design Specification	Trace to Test Cases
2.1	RU1, RU2	Collect and Store data Search data Update contents Display (view) data	3.1, 3.2, 3.3, 4.2, 4.4, 4.5, 4.6	Data repository Data acquisition Simulation repository Data Viewer	Developer Testing
2.2	RU2	Collect and Store data Manage data Data viewing Database administration	4.1, 4.2, 4.4, 4.5, 4.6	Data acquisition Data repository Simulation repository	Developer and System Unit Testing
2.4	RU1	Security Safety Usability Database administration	4.1, 4.2, 4.3, 4.4, 4.5, 4.6	Data repository Data viewer Diagnosis System Tele-presence	Developer Testing
2.5	RU2	Search Data Data viewing	4.2, 4.4	Tele-presence Data viewer Diagnosis System	Developer Testing
2.6	RU1, RU2	Collect and Store data Search data Update contents Display (view) data	3.1, 3.2, 3.3, 3.4	Data acquisition Collaboration Tools Tele-presence Data repository Data viewer Diagnosis System	Developer and System Unit Testing

According to the Requirement Traceability Matrix (RTM) above, nearly all of the user requirements have been addressed by the system developer. However, new requirements may have to be incorporated in future if needs arise.

5.7 System Architecture Design

System architecture design places emphasis on the separation of the different system components such as the databases and presentation. The architecture is composed of three layers: the user interface layer, the application logic layer and the database layer. Each of the layers performs different functionalities which enhance the overall function of the entire system.

5.7.1 Thin-client Architecture

To achieve the system robustness, flexibility and resistance to potential change, the popular three-tier architecture has been chosen for this system. The three-tier architecture aims to solve a number of recurring design and development problems, hence to make the application development work more easily and efficiently (Ribeiro, 2008).

To access the system, the client machines require pre-installed browsers. The implementation of a thin-tier client comes in the form of a three-layer design. This design is an effective approach to developing robust and easily maintainable systems. Corresponding three-tier architecture is shown in Figure 5.3 below:

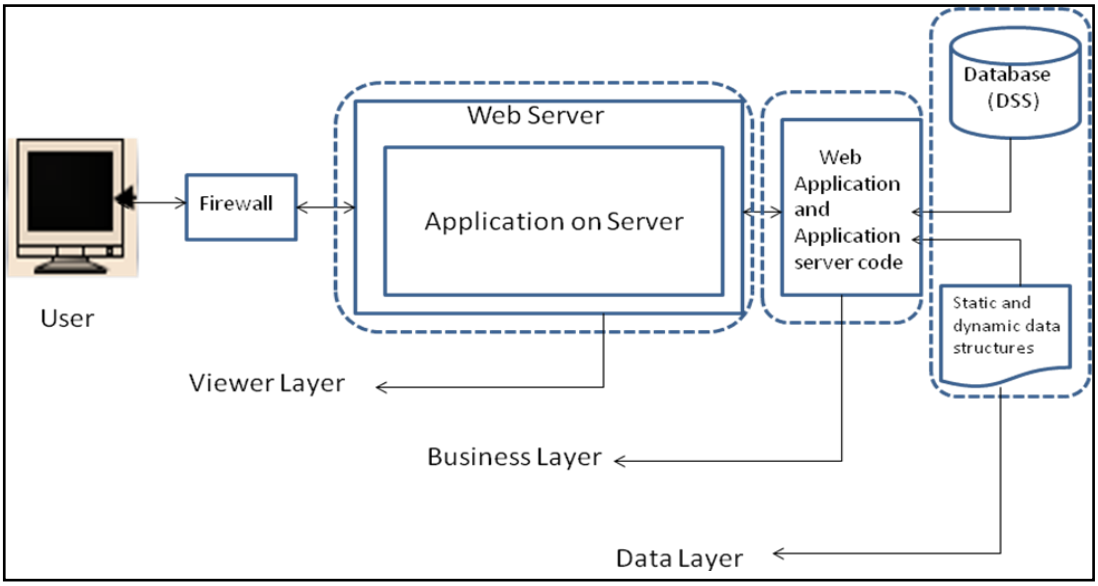


Figure 5.3: Implementation of the Thin-Tier Client Architecture (Adapted from Ribeiro, 2008, with modification by Researcher)

5.7.2 System Interfaces Description

The interface layer in the three-tier architecture offers the user a friendly and convenient entry to communicate with the system while the application logic layer performs the controlling functionalities and manipulating the underlying logic connection of information flows; and finally, the data modeling job is conducted by the database layer, which can store, index, manage and model information needed for this application.

5.7.2.1 User Interface Tier

The first tier is the user interface tier. This tier manages the input/output data and their display. With the intention of offering greater convenience to the user, the system is prototyped on the Internet. The users are allowed to access the system by using any existing Web browser software. The user interface tier contains PHP and HTML components needed to collect incoming information and to display information received from the application logic tiers. The visitors to the web site communicate with the web server via application protocols, such as PHP and HTTP, for sending requests and receiving replies.

5.7.2.2 Application Logic Tier

The application logic tier is the middle tier, which bridges the gap between the user interface and the underlying database, hiding technical details from the users. Active Server Page (ASP.NET) is deployed. Components in this tier receive requests coming from the interface tier and interpret the requests into apropos actions controlled by the defined work flow in accordance with certain pre-defined rules.

5.7.2.3 Database Tier

The database tier is responsible for modeling and storing information needed for the system and for optimizing the data access. Data needed by the application logic layer are retrieved from the database, and then the computation results produced by the application logic layer are stored back in the database.

5.8 The Website/Web Application

The Website/Web Application subproject was developed using the HTML. It consists of a number of Web pages linked together to form one larger system. Each page provides access to other pages in the Website. The Website also provides access link to the ES or Medical Diagnosis Support System (MDSS). A screen shot of the index page of the web site and associated code is shown in Figure 5.4 below:

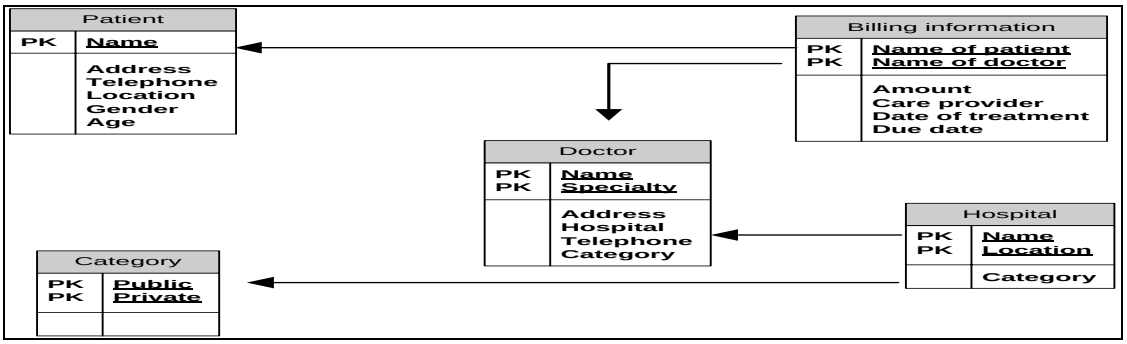
Home Web

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<title>Kibera Health Net Home Page</title>
<meta name="generator" content="Virtual Mechanics SiteSpinner V2 291g - Trial Only">
<meta name="Description" content="The home page for Kibera Health Net. Kibera Health Net is an online
healthcare information system. It is intended for use by the residents of Kibera Slums.">
<meta name="keywords" content="Kibera Health Net">
```

Figure 5.4: Screenshot of KiberaHealth Net Home Page and portion of corresponding HTML Code

5.9 Database

The database subproject was developed using an on-line database application service. The database is embedded within the web site and can be accessed in much the same way as if it were residing on the local machine or network. The database consists of number of data entry forms supported by tables. Figure 5.5 below shows the entity modeling for the on-line database and associated code.



"<iframe height='500px' width='100%' name='zoho-Medical_Specialists' frameborder='0' scrolling='auto' allowTransparency ='true' src='http://www.creator.zoho.com/daniel_odhiambo/treatmens/view-embed/Medical_Specialists/'></iframe>"

Figure 5.5: Entity modeling for the database and associated code that connect to an on-line database

A corresponding screenshot of a typical data entry form is shown in Figure 5.6 below:

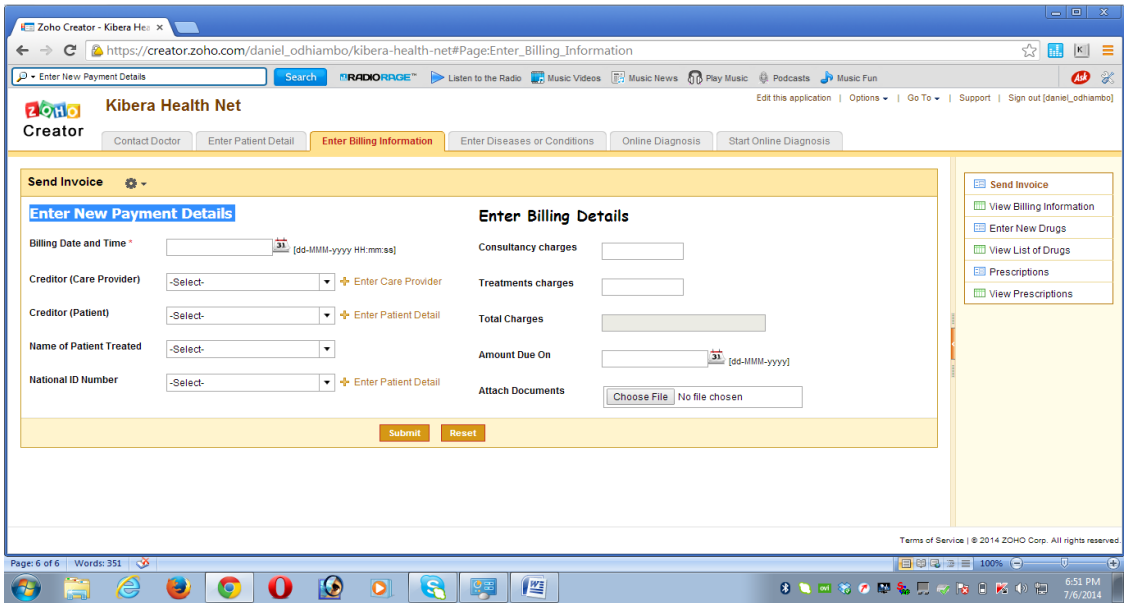


Figure 5.6: Screenshot of the database access form as it appears on Opera Web Browser

5.10 User Interface Design

The user interface comprises the application structure: nodes, links and navigation (Hyperlinks). Screen descriptions are provided to give an insight or detailed views of the system hidden to the common user. Detailed description of each screen and components are given.

5.10.1 Structure and Navigation

The overall structure and navigation of the application is relatively simple, as shown in the following diagram shown in Figure 5.7 below:

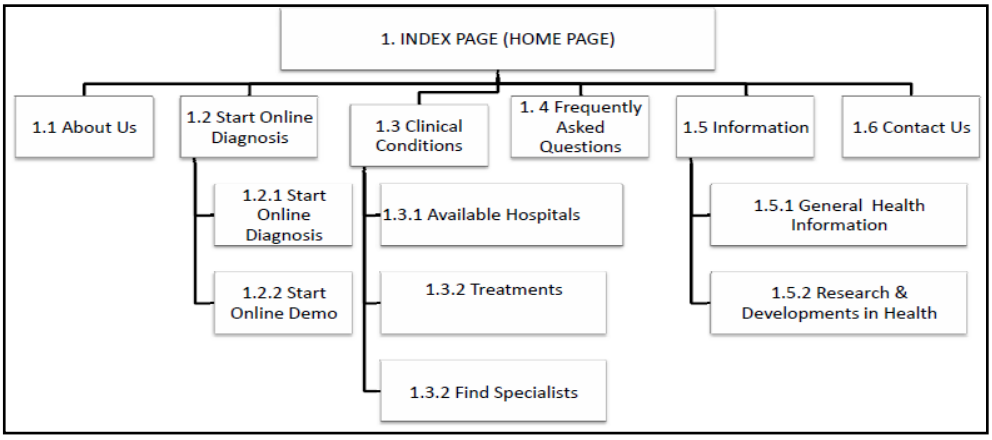


Figure 5.7: User interface diagram

The above diagram represents the application's structure and navigation. It is an indication of the elements to be contained within pages and not just a representation of their appearance. The numbers in the diagram provide a cross-reference to individual screens (pages) described below in this document. There are six primary elements in the site, and each of these may be accessed directly from the main page. Within the pages, primary navigation is provided on the left of the screen in a horizontal list of graphical links. Secondary navigation is provided in a vertical list of text links. Pages are displayed in a single window browser, with the exception of individual clinical conditions together with respective symptoms. The popupwindows contain no browser control; links are provided in close or minimized options only.

5.10.2 Graphical Design Interface

Graphic design contains description of each of the screen or page in the application. Tabular format has been chosen to enhance simplicity and readability because of repetitive nature of the information. Page identification (ID) used in the table has been derived from the user interface diagram shown in Figure 5.6 above. Only the descriptions of the primary screens are provided inTable5.3 below:

Table 5.3: Page Descriptions

Page ID	Description	Navigation	Issues
1.	**Index/Home Page**: provides information about the Web site as well as enables users to access links to other areas within. On clicking relevant links, requested object is displayed in window.	Index/Home Page can be accessed by entering the relevant URL for the Web site, or by conducting a Web search for the site name.	The URL of this page should be kept stable because of the number of external links
2.	**About UsPage**: provides important information about the Web site e.g., Mission and Vision. The screen can be accessed from the Index Page or from other pages within the Web site.	This screen is accessible from the Index Page and other internal pages by clinking relevant links.	Information provided should be accurate and consistent.
3.	**Frequently Asked Questions (FAQs)** Page: provides list of questions with corresponding answers. The screen is accessed by clicking relevant links.	Navigation to this screen is by clicking relevant links. This screen is accessible from the Index Page and other internal pages.	Does not generate automatic replies to user queries. Further exploration is recommended.
4.	**Contact UsPage**: contains contact details about the Web site such as the physical location of the office, address and telephone number (s) of people responsible for the contents etc.	Users can access link to this screen only from the Index Page.	Does not apply for this project, but necessary for real-world implementation of similar projects.

5.10.3 Objects-actions Interface

Object-action interface is an extension to the Graphical User Interface (GUI). It shows how the user can directly manipulate user interface to achieve the desired goals. The interface actions are usually performed by pointing device or keyboard and hence have to be visual to the user so that the user can decompose the plan into steps of actions such as pointing, clicking or dragging. Object-Action Interfaces therefore, provide a snapshot of the real world situations and map the natural way of user's work sequence through the interface as is shown in Figure 5.8 below:

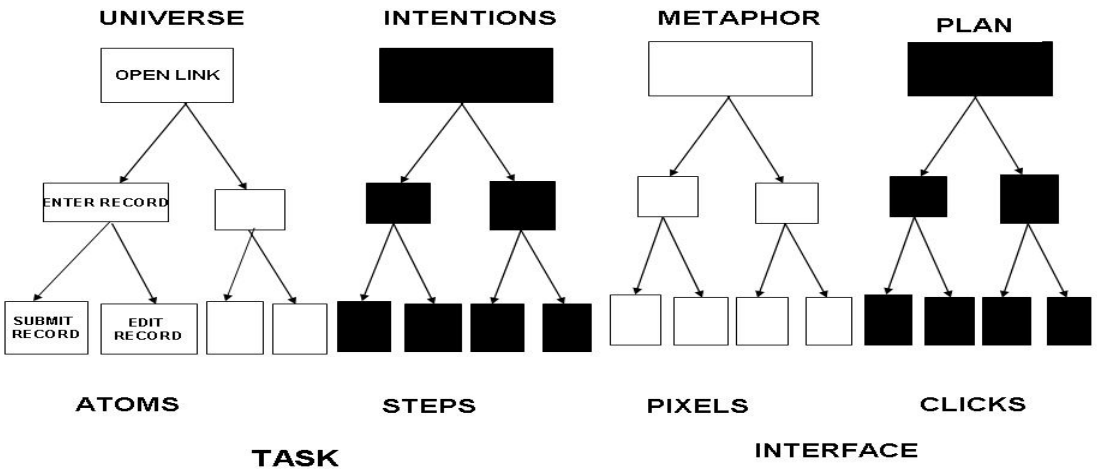


Figure 5.8: Scaled-down user interface design view

The figure above shows the designer mapping from the real world universe of objects and intentions to the interface world universe of metaphors and plans. The interface actions are usually performed by pointing device or keyboard and hence have to be visual to the user so that the latter can decompose his plan into steps of actions such as pointing, clicking or dragging.

5.11 User Help

The purpose of User Help is to provide assistance to users who are not very familiar with the systems. The two user help facilities,the *User*Instructional Manual and *Frequently*

Asked Questions (FAQs) are intended to guide users to conduct self-diagnosis tests and to provide information about and guidance to first time users of the system.

5.11.1 User Instructional Manual

The purpose of the User Instructional Manual is to assist users who are not familiar with the Web-based applications or have limited computer literacy skills. The manual is a simplified User Help System which provides step-by-step procedures on how users can conduct self-diagnosis tests. Figure 5.9 below shows a screenshot of a portion of the used manual.

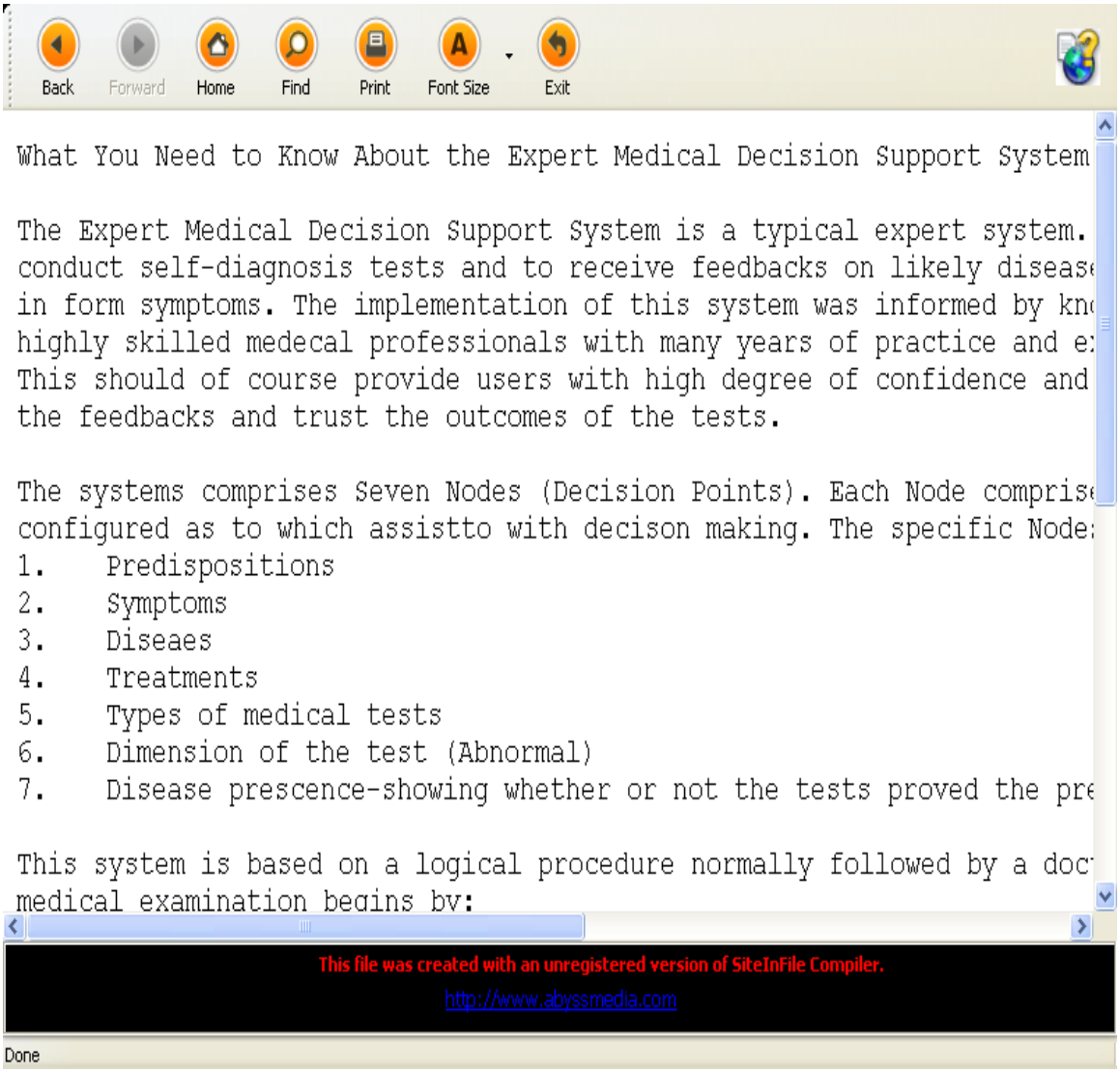


Figure 5.9: A Screenshot of the user instructional manual

5.11.2 Frequently Asked Questions (FAQs)

FAQs page provides access to pre-defined lists of frequently asked questions (FAQs) by users together with corresponding answers. Assorted questions and answers are provided to help users understand different health issues addressed in the Web-site. Information provided is comprehensive in nature and goes beyond the basic "*how to*" procedures. User can find useful guidelines on health-related issues. A screen shot of the FQAs page is shown in Figure 5.10 below:

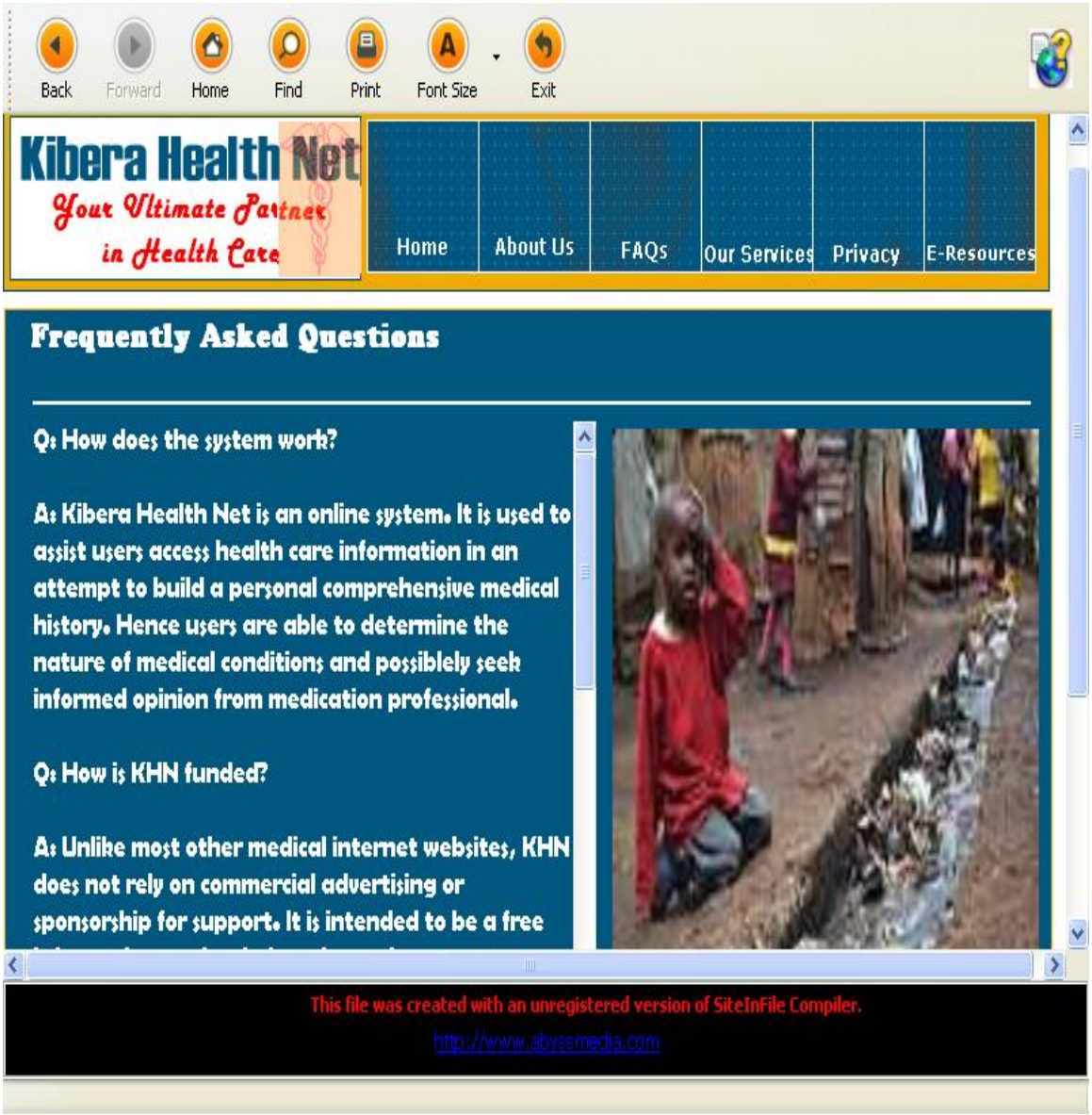


Figure 5.10:A Screenshot of FAQs Page

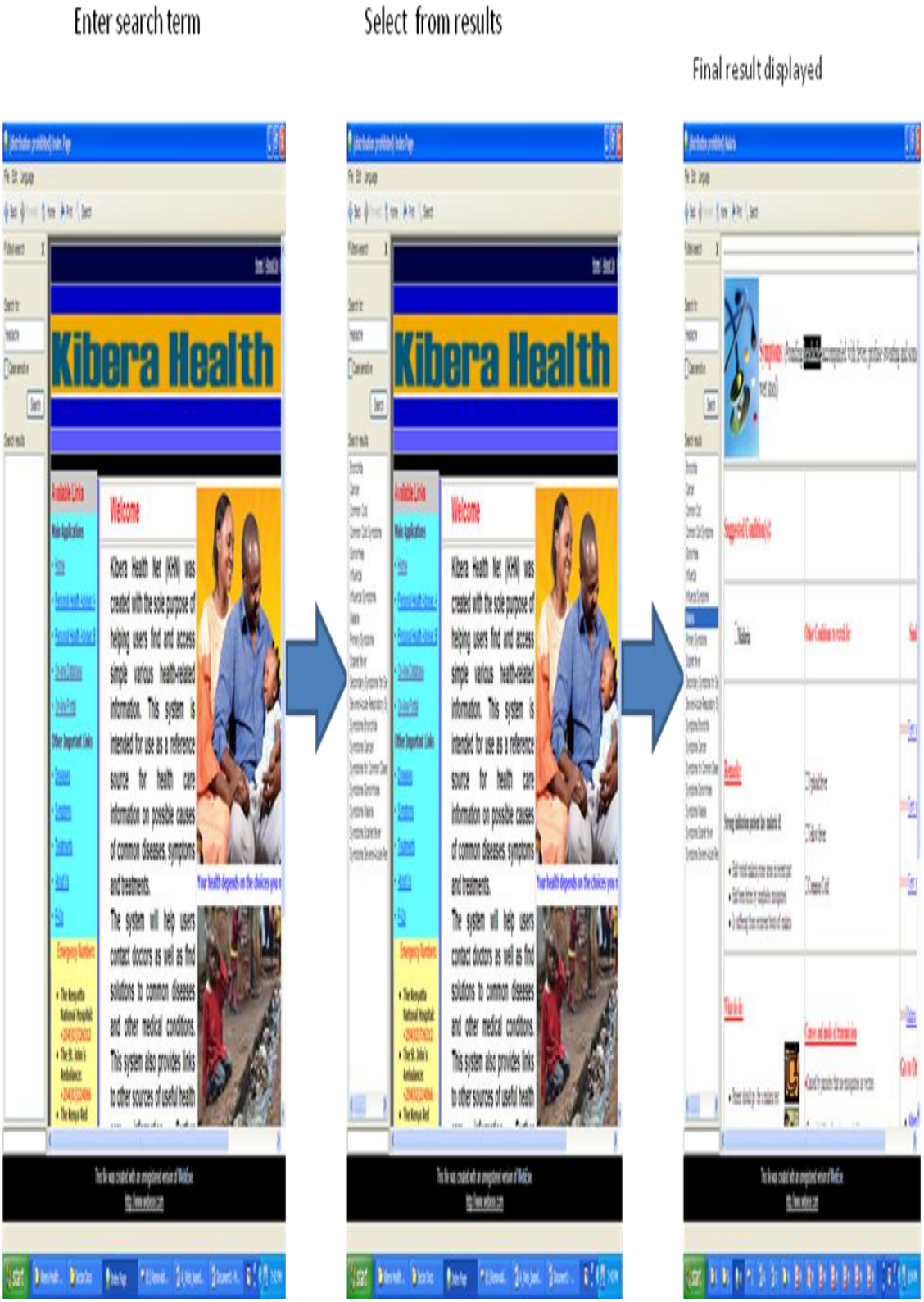


Figure 5.11: Screenshots showing the full text search procedure

CHAPTER SIX

FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This chapter presents the study findings with a view to crystallizing specific findings in relation to research objectives. The findings are presented complete with their statistics. The conclusion is then drawn based on the findings in order to answer the research objectives.Recommendations are provided and suggestions for further research are derived from findings on what should be done to improve healthcare information needs of the residents of Kibera Slums.

The following findings were made:

6.1 Study Findings

The purpose of this study was to investigate healthcare information needs of residents of Kibera Slums with an aim to design a web-based healthcare information system (WHIS). The study indicated variety of demographic characteristics of the respondents such as: age, gender, and number of years respondents had lived in Kibera Slums prior to the study. Five thematic issues were also analyzed. These included: challenges facing accessibility and delivery of healthcare information services to residents, appropriateness of ICT-based solutions to current health challenges, assessment of healthcare information needs of residents for use in system requirements analysis, current level of ICT capacity among residents and designing of a web-based healthcare information system prototype.

6.1.1 General Information

The study findings were derived from research objectives and respondents replies during the survey. Specifically, the study sought to answer the following research objectives:-

i. Determine challenges facing accessibility and delivery of healthcare information services to residents of Kibera Slums.

ii. Explore the appropriateness of an ICT solution to the health challenges in Kibera.

iii. Assess healthcare information needs of residents of Kibera Slums for use in

system requirements analysis, design and development of an ICT-based solution.

iv. Examine current level of ICT capacity among residents of Kibera Slums.

v. Design and develop a web-based healthcare information system prototype for use by residents of Kibera Slums.

These objectives formed the basis of study's problem statement to be addressed. The followingare responses to the questions provided through the analysis of data collected during the investigation:

6.1.1.1 Determine challenges facing residents due to lack of accessibility and delivery of health-relatedinformation services to residents

Regarding the challenges facing residents of Kibera Slums as the result of lack of access to relevant source of health-related information, the study established that the health problems in Kibera Slums were caused by: water borne and contaminated food, malnutrition, drugs and alcoholism, child mortality, HIV/AIDS, physical injuries, and psychological. This finding is consistent with that of similar research conducted by Hemer and Tufte (2011) which indicated that people living in urban slums experience myriad of health challenges. Hemer and Tuftealso concurred on a number of problems these people are facing and listed them as follows: HIV/ AIDS, Tuberculosis, and malaria typhoid fevers and over consumption of drugs and illegal brews.

6.1.1.2 Appropriateness of ICT-based solutions to challenges of inadequate health-related information services

With respect to the appropriateness of an ICT-based solution to the health challenges in Kibera Slums, the study identified communication channels currently used and to evaluated their suitability in the delivery of health-related information services in Kibera Slums. The study established that word of mouth is the most predominant communication channel, followed by radio, print media, television, the Internet and mobile phone for communicating health-related information in Kibera Slums. However, with regards to the suitability or appropriateness of ICT-based solution to the health challenges in Kibera Slums, the respondents favoured the Internet. This view was particularly shared amongst the ICT professionals and the physicians during the interviews, which, was also considered as "informed opinion", given that, these groups of respondents are more

familiar with this type of technologies. These views echo the findings of (Chandrasekhar and Ghosh, 2004). According to them, ICT can also be used as a delivery mechanism to poor and remote locations of a wide variety of services varying from improved public health education to emergency advice, including advice on dealing with and mitigating the consequences of natural disasters. The technological advances have the potential use as a mechanism to increase the transparency and efficiency of governance which would, in turn improve the availability and delivery of publicly provided health services.

6.1.1.3 Healthcare information needs of residents for use in system requirements analysis, design and development

The studysought to assess healthcare information needs of the residents for use in system requirements analysis, design and development. The respondents were asked to identify the problems that are directly associated with lack of access to relevant sources of healthcare information services. The respondents cited unavailability of relevant sources of health-related information services, inadequacy of the available health-related information, and communications barriers within Kibera Slums. This finding concurs with the views of Kahn (2009). Kahn cites several projects in Africa that use ICT in provision of healthcareservices. For instance, the Cell-Life project in South Africa is one of these projects. Backed by local mobile phone giant Vodacom, the project developed software and data management systems that let clinical workers use their mobile phones to monitor patients' treatment and spot health problems before they become life-threatening.

According to Kahn, the phones are equipped with special menus which enable the HIV counselors to record data on patients' symptoms and monitor whether or not the patients stick to drug regimes. These devices are also used to watch out on other factors that might affect patients' health and send them money to pay for transport to the clinic, or to purchase food stuffs. The information collected is instantly relayed over Vodacom's network to a central database, which clinic staff can access over a secure Internet connection(Kahn 2009). Therefore, this can also be possible in a countrysuch as Kenya.

6.1.1.4 Current level of ICT capacity among residents of Kibera

The study sought to examine current level of ICT capacity among residents of Kibera Slums. The respondents were asked to provide information on the number of cyber cafes available within their immediate neighbourhood, who own them and how long they have been in operation. According to Everret Rodger's Diffusion of Innovation theory, the number of adopters is directly dependent upon the level of technological diffusion, in which case, the number of cyber cafes and computers would provide vital information on this. Going by the information provided by the respondents, there has been an increasing trend in the number of cyber cafes and computers in the slums over the years. This only explains that, the number of computer users in Kibera Slums has been increasing over the years, and by extension explains the general upward improvement in terms of computer skills among the residents of Kibera Slums. This upward trend in ICT uptake also means that the residents have been able to embrace the new technologies, particularly, the Internet and the Web.

6.1.1.5 Design and develop a web-based healthcare information system

The study sought to design and develop a web-based healthcare information system prototype. Using data and information collected from the interviews, the researcher had been able to design and develop a web-based healthcare information system prototype. The system can be used to bridge the existing information gap, in addition to providingweb-based solutions to health-related problems in Kibera Slums.This finding supports the finding of recent study on the telemedicine networks by Elmasri(2010). This author is particularly categorical when he suggested that, the overall goal of the nationwide telemedicine network design is to provide affordable and low cost system that facilitates communication between physicians and healthcare professionals across the country. The system implements connectivity among rural clinics and urban area hospitals to be used mainly for tele-consultation and maintaining patient information. As the main design goals, the network should be cost effective, expandable, secure which provides state-of-the-art ICT access scheme to rural area clinics. Existing ICT infrastructure should be given priority to minimize cost of implementing the network (Elmasri, 2010).

6.2 Conclusion

From the findings of the study, the researcher arrived at the following conclusions:

The study concluded that information needs of the residents varied according to gender, status and age. The presence or absence of certain enabling circumstances needs to be taken into account while evaluating use, or potential use of ICT in healthcare delivery. It was revealed that, although residents have shown interests in accessing health-related information using ICT, their level of participation is affected by their social status, e.g. additional roles within the household.

Another significant conclusion of the study was that the overall response of the professional interviewees favoured use of web-based technology and mobile phones for delivery of healthcare to the local communities.This confirms urgent need for alternative channelsthat can be used in communicating health-related information to the residents. This study also confirms that is a very strong correlation between inadequate information sources and health-related problems.

From the study's conceptual model, it could be deduced that with correct level of awareness through provision of relevant health-related information, residents would make informed decisions on matters relating to management of personal health and general wellbeing. Provision of additional health-related information to the resident would also lead to residents' increased level of knowledge or awareness about certain diseases and other health conditions. This in turn would lead to better management of personal health and general well-being, with the end result being a healthy population!

6.3 Recommendations

The recommendations presented relate to the specific findings of the study and to broader policy perspectives. Based on the foregoing discussion of the findings and conclusion, this study recommends the following:

1. **Government to implement a Web-based Healthcare Information System for Kibera Slums**

The study revealed that the residents required ICT-based solutions to address current health problems in the slums. Technologies like web-based information systemscould enhance delivery of healthcare information services in Kibera Slums. Residents needed structured health-related information for them to make informed decisions on how to manage personal health and general well-being.

2. **Government to take leading role in promoting of use ICT-based solutions in delivery of healthcare services**

The government should take advantage of emerging ICT-based solutions and use them to deliver healthcare services to the people. Because of the high costs of the new set of technologies, there is need for the government to step in and assist local communities acquire the technologies.

3. **Government needed to improve telecommunication infrastructure in Kibera Slums**

This study calls on the government to take conscious steps to improve the telecommunication infrastructure in Kibera Slums to leverage ICT diffusion in the area. Establishing new innovations for Internet access points like digital villages or tele-centres in the slums can help fast-track ICT uptake in the slum.

4. **Government should develop national policies and guidelines on use of ICT in the health sector**

The study found out that a significant factor inhibiting the use of ICT for the healthcare delivery in the country was the lack of an articulate national ICT policy to guide their operations. Therefore, the study recommends implementation by the government of national polices and guidelines for integration of information technology into the national healthcare system.

5. **Government should promote community involvement in ICT-based solutions for health care delivery**

Many government initiatives are being developed which do not bring end-user at the table. Taking a more of a human-centered approach to developing web-based healthcare information system initiatives will be crucial for sustained demand, and can be achieved by finding a balance of working with Ministries of Health in addition to local communities.

6. **Government to provide capacity building to local communities where ICT-based solutions for healthcare delivery are implemented**

Additional efforts in educating the health professionals about the potential role of ICT-based solutions in healthcare delivery would be critical for mass adoption. The focus should be beyond the benefits to professionals alone by also including end-users.

Sustainable use of web-based healthcare information system would weigh heavily on a workforce that is able to support it and to effectively use the tools being created. Training of healthcare professionals, as well as end-users should be happening concurrently as the field advances.

6.4 Recommendations for further research

With regards to the need to carry out further research, the study recommended that:

Further research should be conducted in other districts in Kenya to fully gain more insight into topic in order to find out if the findings reached here hold true for the whole republic.

Significant issues that need careful attention and further research are highlighted in this study. The study observes that introduction of ICT in community healthcare delivery is new innovation. But absence of suitable policy environment has continued to hinderpromotion of ICT in healthcare delivery in Kenya. Therefore, the study underscores the need for policy makers and ICT researchers to explore further the benefits that would accrue from the use of ICT-based solutions as a means of achieving universal healthcare in the country.

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APPENDIX I: SYSTEM REQUIREMENTS SPECIFICATIONS DOCUMENT

1. 0 Introduction

This section presents the technical information on the system requirements specifications document used to develop the system. The document offers an overview of the scope, purpose and functionalities of the intended system. The system requirements specifications document covers all the functional areas of the system.

1.1 Purpose

The purpose of system requirements specifications document is to provide the descriptive information on the functions and requirements of the system to be developed. The system will be deployed for use in delivery of healthcare information services to residents of Kibera Slums. To achieve this objective, the system will facilitate accessibility of and ensure equitable provision of health-related information to the residents.

1.2 Intended audience

The system will be deployed for use in the larger Kibera Slums. More specifically, the system will be used by the residents to access to healthcare. This means that the system's information contents will be developed with the people of Kibera Slums in mind, so as to enable them benefit from it. Residents in need of information on how to manage personal health will readily find it on the system. At the same time, the system will help the clients to interact with other key players in the healthcare sector such as physicians, insurance companies, medical institutions and pharmacies.

1.3 System requirements specifications team

SRS team will include the developer and any person as may be deemed necessary.

2.0 Overall description

2.0 Overview

This section provides brief descriptions of system and highlights the basic system's functional components.

2.1 Product perspective

The intended system will be a web-based application. It will be used to deliver on-line healthcare services to the clients. The user base or clientele will include people living in Kibera Slums (patients and their relatives) and any other key players in the healthcare sector.

2.2 Product functions

The system will comprise three modules namely: Website—Web application, database and medical decision support system. Each module will be assigned specific functions as follows:

Web site—Web application—for deployment of the WHIS

Database—for storage of disease/symptom/treatment information

Decision support system (DSS)—for storage of domain expert knowledge

2.3 User classes and characteristics

The system's user classes will comprise the following:

Clients: seeking health-related information in order to make informed health decisions,

Medical professionals: interacting with and/or providing medical service to patients,

Key stakeholders: individuals or organisations dealing with health related issues in the village.

System administrator: updating Web contents and providing user guidance, and ensuring smooth operation and security of the system.

2.4 Operating environment

The system will be hosted on a PC server that runs on Windows environment. The system will be accessible on-line through a browser. The system's architecture will be based on the thin-client model which is the de facto standard for developing Web applications. A thin-client application is most readily associated with a browser-hosted user interface (UI), which is dynamically generated and sent to client in form of HTML by server.

2.5 User environment

The system will provide on-line accessible to users. To access the system on-line client machines will have to have a browser pre-installed on them.

2.6 Design/implementation constraints

The system will be run on a desktop computer under Windows environment and connected to the Internet. Under this construction, the system will respond to user inputs with minimal response time. Features of the system will be:

- Application server software shall be written in Java.
- Client software shall be written in Java.
- User client software shall be written in HTML, CSS, and JavaScripts.

3.0 External interface requirements

System's interface requirements will include both the user interfaces and hardware interfaces.

3.1 User interfaces

User interfaces enable system users to interact with and provide access to different parts of the system. The main system clientele will comprise of the following actors:

Clients: seeking health-related information in order to make informed health decisions,

Medical professionals: interacting with and/or providing medical service to patients,

Key stakeholders: individuals or organisations dealing with health related issues in the village.

System administrator: updating Web contents and providing user guidance, and ensuring smooth operation and security of the system.

3.2 Hardware interfaces

The hardware interfaces will comprise user-client desktop computer, ISP, network infrastructure, and the server. System's hardware components will be connected together by the telecommunications infrastructure.

3.3 Software interfaces

Software interfaces will comprise the following:

- Web browser
- Firewall
- Application software
- Decision support software
- Databases

3.4 Communication Protocols and interfaces

The system will mainly use HTTP and FTP for data transmission. The server and the Internet Service Provider (ISP) will be connected through a dedicated telephone line or wireless connection.

4. System Features

The main features of the Web based healthcare information system will be:

4.1 Server

The server will house the Website as well as provide a link to the Internet through the ISP. The server will also enable for changes and updates to be made on the Web site. The server will provide the following functional characteristics: high processing speed, capability to interoperate with other systems on the network, compatibility with commonly used software, performance tolerance and system resilience.

4.2 User client desktop computer (PC)

Client PC will be used to provide on-line access to the system.

4.3 Firewall

The firewall will be installed in between the server and the Internet to protect the server from external attacks. The purpose of the firewall is to provide proxy access to the server and protect the LAN from direct external access as well as the databases and stored system configuration data sets.

4.4 Web browser

Web browser enables users to interact with the system. A Web browser provides the interface between the server and client computer, and presents and displays information in a user friendly format.

4.5 Application server and application code

The application server is the platform in which the databases will be housed. Communication between the databases and the browser is provided by the application server. The application server also houses the application code. The application server receives data from the browser in HTML form, and transforms it into plain text for interpretation by the application code. The application code converts the plain textual data into code and forwards it to the database as requests. The database responds by sending back the requests through the same process.

4.6 Database

The system will comprise a database. The database will be used to store data on disease/symptoms and treatments. The databases will enable stakeholders to access different data sets which they may need to make informed decisions.

4.7 Other features

Other features of the system will include data management, security and Web page. Data management and security functions will enable system administrator to manage the system and to set up security parameters to ensure safety of data sets respectively. Web pages will enhance information access by users.

5. Nonfunctional requirements

5.1 Performance requirements

The system is intended for delivering healthcare services in the form of health-related information which the residents use to make health-related decisions. To achieve this goal the system will be expected to deliver equitable health-related information in an efficient and effective manner. Also, the services should be both users centred and cost effective/affordable. In addition, the services should always be available and accessible from anywhere.

5.2 Safety requirements

The system will ensure the safety of equipment, data, and users. Computers and other communications equipment will be kept in secured premises and will be accessible to authorized personnel only. Health-related information will be subject to verification by medical staff prior to posting on the Web site. Users will be always advised to seek informed opinion from qualified medical professionals before they can put into practice the information from the Web site.

5.3 Security requirements

The system will implement security parameters for authorized access based on user groups, profiles and roles. This is to enable only authorized users to access relevant data depending on groups, profiles and roles assigned to them by the system administrator. Where authorized, users will be required to use their password to access the objects. Users will be advised to protect their passwords and ensure they don't share them with other people.

5.4 Software quality attributes

The system once completed will have the following the attributes:

Interactivity: includes structural principles of contingency, participation, synchronicity, proximity, and richness of nonverbal contextual information.

Presence: computer-stimulated physical presence occurs when the user subjectively experiences non-present real or virtual objects. Social presence involves perceived contact with real or imaginary others. And self-presence occurs when the computer interaction produces revelations or alterations of self-perception.

APPENDIX II: INTERVIEW SCHEDULE FOR HEALTH PRACTITIONERS

Personal Information

1. How long have you been working or living in Kibera Slums?
2. What are your academic qualifications?
3. What is your area of specialization?
4. Do you have any relevant training in computer application? If yes, what level?

Current health-related problems among the residents of Kibera Slums

1. What are the most common health-related problems among the residents of Kibera Slums?
2. In your opinion, what are the main causes of these problems?

Access to health-related information by residents of Kibera Slums

1. What challenges do you think Kibera Slum residents face in accessing healthcare information services?
2. Which channels do the residents of Kibera Slums use to access healthcare information services?
3. How would you rate each of thecommunications channels in respect effectiveness in delivery of healthcare information services?

Suitability of web-based technologies for delivery of healthcare-related information

1. Do you use the Internet and Web to access healthcare information services?
2. Have you ever used a web-based healthcare information system?
3. Do you think computer system would be more effective for delivery of healthcare information services?
4. Which characteristics would you consider desirable for computer systems used to deliver healthcare information services?
5. In your own opinion, how would easy accessibility of healthcare information influence the way people make long-term health-related decisions?

Thank you for participating in this interview.

APPENDIX III: INTERVIEW SCHEDULE FOR RESIDENTS AND AREA LEADERS

Personal Information

1. How long have been living in Kibera Slums?
2. What are your academic qualifications?
3. Do you have any relevant training in computer application? If yes, what level?

Current health-related problems among residents of Kibera Slums

1. What health-related problems are you experiencing as a resident of Kibera Slums?
2. In your opinion, what are the causes these problems?
3. What do you to solve these problems?

Access to health-related information by the residents of Kibera Slums

1. What challenges you face accessing to healthcare-related information?
2. Which communication channels do you use to access to healthcare-related information?
3. In your own opinion, which channel do you think is most effective in communicating health-related information to the residents of Kibera Slums?

Suitability of web-based technologies for delivery of healthcare-related information

1. How many Internet centres (cyber cafes) are there in your neighbourhood?
2. Have you used the Internet to access to healthcare-related information?
3. Do you think the Internet is suitable for delivery of healthcare information?
4. Which features would you consider desirable for a web-based healthcare information system?
5. In your own opinion, how would easy accessibility of healthcare information influence the way people make long-term health-related decisions?

Thank you for participating in this interview.

APPENDIX IV: INTERVIEW SCHEDULE FOR ICT PROFESSIONALS

Personal Information

1. How long have you been living and/or working in Kibera Slums?
2. What are your academic qualifications?
3. Is this your first work station since you graduated?
4. Do you have any relevant training in computer application? If yes, what level?

Information usability patterns among the residents of Kibera Slums

1. How many Internet centres (cyber cafes) are there in your neighbourhood?
2. What kind of information do users commonly seek from the cyber cafes?
3. In your opinion, do you think users are being satisfactorily served?
4. Are your users been able to use computer without assistance?

Access to health-related information by the residents of Kibera Slums

1. Are there any healthcare information services in your neighbourhood?
2. How often do the residents of Kibera Slums ask for healthcare-related information?
3. Apart from the Internet which other communication channels do the residents use to access specialized health-related information?
4. In your own opinion, which channel do you think is most effective in communicating health-related information to the residents of Kibera Slums? And why?

Suitability of web-based technologies for the delivery of healthcare services

1. Do you think web-based healthcare information systems could be useful in delivery of healthcare information to people living in your neighbourhood?
2. As an expert what are some of the desirable characteristics you would expect of a Web based healthcare information system?
3. In your own opinion, how would easy accessibility of healthcare information influence the way people make long-term health-related decisions?

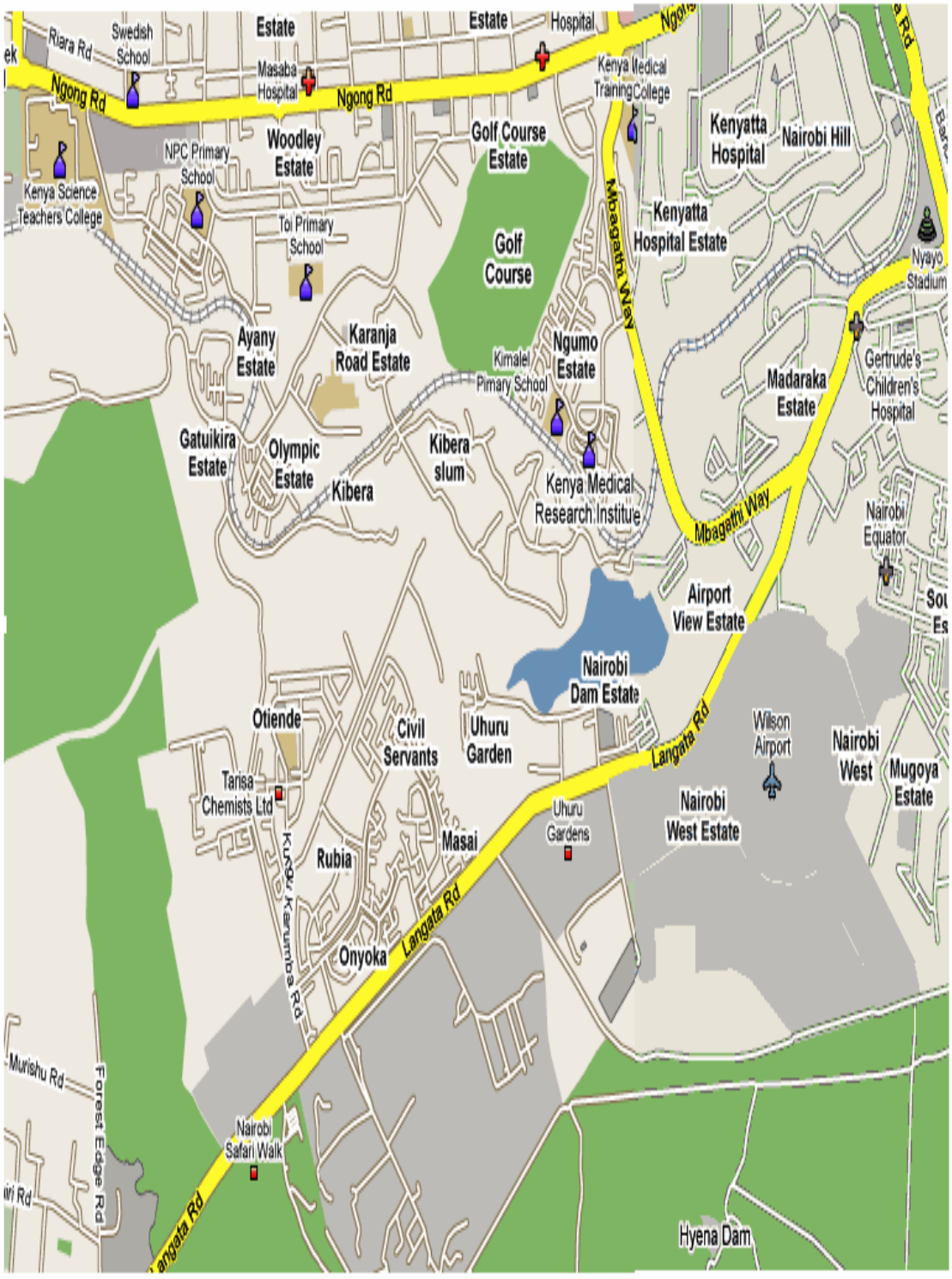
Thank you for participating in this interview.

APPENDIX V: A SAMPLE SIZE SELECTION TABLE

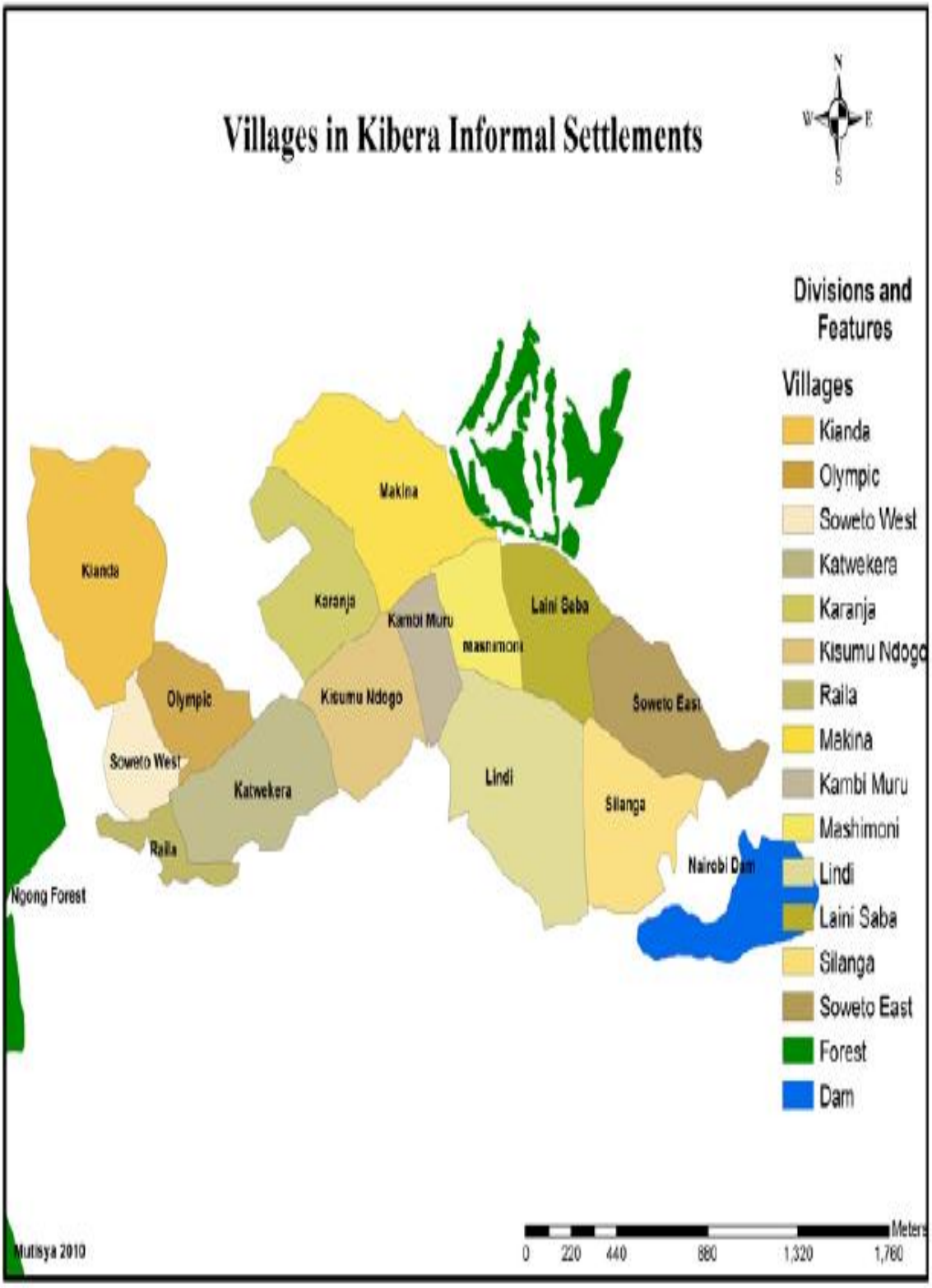
Required Sample Size†

Population Size	Confidence = 95% Margin of Error				Confidence = 99% Margin of Error			
	5.0%	3.5%	2.5%	1.0%	5.0%	3.5%	2.5%	1.0%
10	10	10	10	10	10	10	10	10
20	19	20	20	20	19	20	20	20
30	28	29	29	30	29	29	30	30
50	44	47	48	50	47	48	49	50
75	63	69	72	74	67	71	73	75
100	80	89	94	99	87	93	96	99
150	108	126	137	148	122	135	142	149
200	132	160	177	196	154	174	186	198
250	152	190	215	244	182	211	229	246
300	169	217	251	291	207	246	270	295
400	196	265	318	384	250	309	348	391
500	217	306	377	475	285	365	421	485
600	234	340	432	565	315	416	490	579
700	248	370	481	653	341	462	554	672
800	260	396	526	739	363	503	615	763
1,000	278	440	606	906	399	575	727	943
1,200	291	474	674	1067	427	636	827	1119
1,500	306	515	759	1297	460	712	959	1376
2,000	322	563	869	1655	498	808	1141	1785
2,500	333	597	952	1984	524	879	1288	2173
3,500	346	641	1068	2565	558	977	1510	2890
5,000	357	678	1176	3288	586	1066	1734	3842
7,500	365	710	1275	4211	610	1147	1960	5165
10,000	370	727	1332	4899	622	1193	2098	6239
25,000	378	760	1448	6939	646	1285	2399	9972
50,000	381	772	1491	8056	655	1318	2520	12455
75,000	382	776	1506	8514	658	1330	2563	13583
Kibera's Population falls here → 100,000	383	778	1513	8762	659	1336	2585	14227
250,000	384	782	1527	9248	662	1347	2626	15555
500,000	384	783	1532	9423	663	1350	2640	16055
1,000,000	384	783	1534	9512	663	1352	2647	16317
2,500,000	384	784	1536	9567	663	1353	2651	16478
10,000,000	384	784	1536	9594	663	1354	2653	16560
100,000,000	384	784	1537	9603	663	1354	2654	16584
300,000,000	384	784	1537	9603	663	1354	2654	16586

APPENDIX VI: A MAP OF KIBERA SLUMS SHOWING TERRAINS



APPENDIX VII: A MAP SHOWING THE VILLAGES IN KIBERA SLUMS



APPENDIX VII: A GRAPH SHOWING THE NUMBER OF VILLAGES IN KIBERA SLUMS