# Mobile Hospital Services Locator

## Case of Hospitals in Nairobi County

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# Abstract

To date, In Kenya online hospital rankings are virtually nonexistent. In the U.S. however, in a context where health is more in tune with market forces and consumerism (government agencies and corporations purchasing "care, contacting suppliers about their services, guardianship wishes to standardize the 'Information on the provision of care and promote "informed choice" in patients) sites rating has been around for years. *Online rankings* differ in their objectives and their methods.

This is a documentation that creates awareness of how different hospitals perform their operational services and what best they can give. The proposal considers the outstanding challenges in the way people rate the hospitals and their services. The probable solution to the challenge is discussed in depth. These aspects are covered thorough critical review of the existing literature.

A proper explanation of the project has been done. The methodologies and approach to be used as well as the target market have been identified. The proposal also outlines how each milestone shall be achieved and expected deliverables. To wrap it all, an extensive architecture of the proposed solution has been discussed.

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# Declaration

This research proposal is my original work and has not been presented for a degree in any other university. No part of this proposal may be reproduced without the prior permission of the author and/ or Strathmore University. All other sources of information cited herein have been duly acknowledged.

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**SUPERVISOR(S) DECLARATION**

This research proposal has been submitted for review with my/our approval as university Supervisor.

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# Acknowledgements

The process of researching and coming up with this system from the design and analysis phase to the implementation was tedious and time consuming but this was proven easy by the help from informative people and a considerable amount of effort from me.

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Finally, my gratitude also extends to my family for their support they have given me for all the assistance awarded to me during the design phase of this project.

To all those who helped me in the production of the system, I stretch out my gratitude to them all and may God bless them all.

# Abbreviations/ Acronyms

| | | |
|---|---|---|
| **BMI** | - | Body Mass Index |
| **CDMA** | - | Code Division Multiple Access |
| **EPR** | - | Electronic Patient Records |
| **GDP** | - | Gross Domestic Product |
| **GPS** | - | Global Positioning System |
| **HMOs** | - | Health Maintenance Organizations. |
| **RTLS** | - | Real Time Location Systems |
| **ITU** | - | International Telecommunications Union |
| **IT** | - | Information Technology |
| **IS** | - | Information Systems |
| **LBS** | - | Location Based Service |
| **MHS** | - | Mobile Healthcare Systems |
| **NAHIT** | - | National Alliance for Health Information Technology |
| **OECD** | - | Organisation for Economic Cooperation and Development |
| **OGC** | - | Open Geospatial Consortium |
| **PAHO** | - | Pan-American Health Organization |
| **PACS** | - | Picture Archiving and Computing Systems |
| **RFID** | - | Radio Frequency Identification |
| **UCSF** | - | University of California at San Francisco |
| **WHO** | - | World Health Organization |

# Definition of Terms

**Android**          A software created by the technology company Google and is used to run mobile devices.

**App**              Mobile Application installed on a mobile device.

**Cloud Computing**  The delivery of computing and storage capacity as a service to a community of end-recipients (Carr, 2012).

**IPad**             Mobile device created by a technology company apple.

**Java**             A programming language used in system and software development.

**Safaricom**        The largest Mobile operator in Kenya.

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# Chapter 1: Introduction

## 1.1 Background

### 1.1.1 Hospitalization services in Nairobi County

Making an informed decision about the quality of hospital care requires accurate information, especially for managed care systems with their incentives to minimize cost. As these systems provide an increasing portion of the medical care in Kenya, the need for valid and reliable outcome measures will increase. The services offered in a hospital and their charges are important and well-accepted outcome measure for hospital care.

It is, however, difficult to detect statistically significant differences in charges and services offered across hospitals. Because of these limitations, some analysts have suggested using Information about hospital services and prices to rank hospitals. One approach is to combine the services with their costs to create a merged outcome. Another approach is to use areas of expertise in a particular hospital and one can decide which hospital to be attended.

Different services have got different charges, and thus it seems reasonable to suggest that using them to rank hospitals should offer some advantages.

### 1.1.2 The growing market for location-based services

As smart phones like the Apple iPhone, Google Android-based devices and Research In Motion‟s BlackBerry have become increasingly popular, so has the use and ubiquity of LBS. Frost and Sullivan predict 20 percent of users will make use of LBS by 2012 [Vaughan-Nichols, 2009]. Juniper Research [2010] has predicted the size of the mobile LBS market to exceed $12 billion by 2014. Much of this comes from application sales, with mobile advertising set to drive growth over the next five years. These figures show a large and growing consumer market. LBS can provide much benefit for enterprise operations such as asset tracking and locating. Realising this potential, many organisations are jumping on the bandwagon using specialised hardware. However, as more smart phones are deployed into the enterprise, the advanced sensors and features of these devices, such as inbuilt GPS receivers, can be used to provide even more cost-effective LBS to workers and customers.

### 1.1.3 The Cisco Location-Aware Healthcare Solution

Intelligence about the location of mobile resources streamlines business and clinical processes and frees staff to deliver high-quality care. Nursing staff and caregivers work in high-stress, high-risk, data-intensive environments that are often dominated by paper-based processes and inefficient workflows. Given the extreme time pressures these professionals experience, it's a constant challenge to increase the time they have available to spend with patients while reducing lower-value tasks that can affect their overall efficiency and effectiveness. Now leading healthcare organizations are adopting location solutions to improve their awareness of critical resources, including equipment and people. In the RFID in Healthcare Survey from BearingPoint and the National Alliance for Health Information Technology (NAHIT), respondents indicated that they believe spending on RFID will dramatically increase beginning in 2007. Nearly 74 percent of respondents said they anticipate their companies will invest in RFID by that year, with nearly 39 percent expecting their firms to spend US$250,000 or more on the technology in 2007 and 2008. Large organizations plan to spend considerably more, $1 million to $5 million, during that same two-year period. Driving that spending will be a shift from pilot RFID projects to production systems, expanded live RFID deployments. As part of the Cisco® Medical-Grade Network, the Cisco Location-Aware Healthcare solution can help healthcare organizations monitor and optimize workflows and increase responsiveness as well as productivity and efficiency.

### 1.2 Problem Statement/ Opportunity Statement

Most people in Nairobi do not have clear information on where a particular hospital is located unless they are directed by a friend or stumbled upon either by physically passing near them or reading advertisements. To get known, the hospitals need to invest heavily on advertising but since this is very expensive many smaller healthcare opt to rely on their local customers and customers who stumble upon the hospital as they are passing by for any check ups.

Most people get to know all this information by word of mouth but not from available resourceful information/sources, This may confuse the patients and they end up forgetting which hospital charges relatively cheap in a given service and the area it falls in, hence the patients finds themselves in a hospital which they were not expecting causing the patients to change from one hospital to another within the course of the treatment and this is highly discouraged especially by the doctors. Others are retained in the hospital due to failure to clear their bills hence increasing the costs.

Several People in Nairobi do not have an idea of how different hospitals charge their services and what each hospital specializes in. These hospitals differ in terms of their area of expertise, services offered and the prices charged e.g. Mater Hospital is known to have the best heart facility and St. Mary's have best Maternity facility.

Solutions that have been developed to solve this problem are either not localized within the Nairobi County hence the need for a Hospital Selector/Locator System.

## 1.3 Research objectives

i. Identify the hospital services and the fees charged for the services

ii. Review existing mobile applications used in the hospital industry.

iii. Design a Hospital Selector/Locator System

iv. Implement a Hospital selector and locator system

v. Test a Hospital Selector/Locator

## 1.4 Research Questions

i. What are the hospital services and fees charged for the services?

ii. What are the existing mobile applications for selection and location of hospital services?

iii. How would one design the Hospital Selector/Locator System?

iv. How would the Hospital Selector/Locator be implemented?

v. What would be the best way to test the Hospital Selector/Locator system?

## 1.5 Justification

This study suggests a solution to provide a reliable, quick and quick communication channel between hospitals and their clients. The hospitals would not need to use a lot of funds to raise awareness of their existence, location and the services they offer. They would only update their details in the system and their clients would always be informed. The clients on the other hand have a centralized location to search for the services offered in different hospitals, their prices and the hospital location.

The result of this study is an improvement in the communication between Nairobi county hospitals and the patients hence enabling hospital management to make informed decisions when coming up with new methods to improve service delivery to their clients, hence better customer satisfaction and a generally improved hospital lifestyle of citizens who visit these hospitals.

The government is ready to invest in solutions that will improve the technological infrastructure as can be seen by the goals set in its vision 2030 mandate (*kenya_vision_2030_abridged_version.pdf*, 2008). There is also a lot of investment in the telecommunications industry and especially in the mobile space as can be seen from the rise of incubators and mobile competitions such as Pivot25 and Google Code Jams etc. The GSMA announced in October 2007 that mobile operators plan to invest approximately $50 billion in Sub-Saharan Africa over the following five year period (―Africa & Middle East Telecom,‖ 2008).

Most people have access to mobile phones. The mobile data space is very quickly growing and there is a lot of investment in this area. The solution makes use of a tool readily available to the public to provide them with a solution to better their life style.

## 1.6 Scope limitation
The research is targeted at growth market areas. The research will focus on Nairobi County specifically due to the high availability of different hospitals within. Also Nairobi County was chosen as it is a convenient place for the researcher to conduct her research with the resources available to her.

At the end of the research duration, the deliverables expected were as follows:

    i.    A functional Hospital Locator Mobile Application.

    ii.    An Instruction Manual on Installation, Setup and running the application.

    iii.    Research Report

## 1.7 Assumptions
    i.    The Management of Nairobi county  Hospitals will be computer literate enough to put in the hospital details in the hospital locator system

    ii.    The Management personnel of these hospitals will be system willing to provide information about their services and the prices for these services

iii.    Most clients or those willing to use the system will own internet and java enabled mobile phones.

## 1.8 Summary

In this chapter we have discussed the background of hospital services in Nairobi County, the growing market for location-based services the problems faced by the hospital industry and the way mobile devices have been used to provide solutions to some problems faced by human beings and especially the patients. We have also discussed the objectives the research set out to meet and the questions it intended to answer. Finally we have seen the importance of this research, its scope, limitations and the assumptions it makes.

# Chapter 2: Literature Review

## 2.1 Introduction

### 2.1.1 Hospital

A **hospital** is a **health care** institution providing **patient** treatment by specialized staff and equipment. Hospitals are usually funded by the public sector, by health organizations (for profit or nonprofit), health insurance companies, or charities, including direct charitable donations. **Hospital administration** or **healthcare administration** is the field relating to leadership, management, and administration of hospitals, hospital networks, health care systems, and public health systems. (―Hospital - Wikipedia, the free encyclopaedia,‖ n.d.)

### 2.1.2 Hospital services

A hospital service is a term that refers to medical and surgical services and the supporting laboratories, equipment and personnel that make up the medical and surgical mission of a hospital or hospital system.

Hospital services make up the core of a hospital's offerings. They are often shaped by the needs or wishes of its major users to make the hospital a one-stop or core institution of its local community or medical network. Hospitals are institutions comprising basic services and personnel—usually departments of medicine and surgery—that administer clinical and other services for specific diseases and conditions, as well as emergency services. Hospital services cover a range of medical offerings from basic health care necessities or training and research for major medical school centers to services designed by an industry-owned network of such institutions as health maintenance organizations (HMOs). The mix of services that a hospital may offer depends almost entirely upon its basic mission(s) or objective(s). There are three basic types of hospitals: proprietary (for-profit) hospitals; non profit hospitals; and charity- or government-supported hospitals. The services within these institutions vary considerably, but are usually organized around the basic mission(s) or objective (s) of the institution:

    a) **Proprietary hospitals**. For-profit hospitals include both general and specialized hospitals, usually as part of a healthcare network like Humana or HCA, which may be

corporately owned. The main objective of proprietary hospitals is to make a profit from the services provided.

b) **Teaching or community hospitals**. These are hospitals that serve several purposes: they provide patients for the training or research of interns and residents; they also offer services to patients who are unable to pay for services, while attempting to maintain profitability. Non profit centres like the University of California at San Francisco (UCSF) or the Mayo Clinics combine service, teaching, and profitability without being owned by a corporation or private owner.

c) **Government**-supported hospitals. This group includes tax-supported hospitals for counties, communities and cities with voluntary hospitals (community or charity hospitals) run by a board of citizen administrators who serve without pay. The main objective of this type of hospital is to provide health care for a community or geographic region.

## 2.1.3 Hospital Industry in developing countries

The globalization of the health-care industry is proceeding. It is being driven by the high cost of health care in the developed countries, compounded by the steep rise in demand for health care as a result of the ageing of populations in these countries and the increasing availability of health-care services in developing countries at less expensive rates than in developed countries. Increasingly, patients are sourcing health care globally and opting for the most affordable treatment. In a growing number of fields of treatment, the most cost-effective option is travelling to a developing country. The provision of health care has significant potential for those developing countries that can provide world-class services and facilities at internationally competitive prices. The proximity of the Caribbean to the United States gives it an additional advantage in meeting the rapidly growing demand for health care originating in that country.

Over the past two decades, hospital services in the United States have declined markedly as a percentage of health care costs, from 43.5% in 1980 to 32.8% in 2000. This decline was due to shortened lengths of hospital stay, the move from inpatient to outpatient facilities for surgery, and a wave of hospital mergers in the 1990s that consolidated services and staff. Since 2001, however, spending on hospital care in the United States has been growing faster than other sectors of the economy as a result of increasing demand for hospital services. Forty percent of the rise in spending on hospital care is due to escalating costs for hospital services

attributed to population growth, the aging of the general population, and growing discontent with the limitations imposed by managed care. In addition, new medical technologies have allowed hospitals to provide life-saving diagnostic and therapeutic alternatives that were unavailable in the 1990s.

At the same time that the use of hospital services is increasing nationwide, government support of hospital services with **Medicaid** and **Medicare** has been decreasing, putting pressure upon hospitals to treat the uninsured and make up for $21.6 billion in uncompensated care (year 2002). This trend has put pressure on for-profit, not-for-profit and teaching hospitals to provide a broader range of community services or such "low-end" services as mental health care, preventive health services, and general pediatric care. In addition, very recent changes in Federal laws governing the entry of hospitals into new markets—Certificate of Need laws—allow health care providers to offer new hospital services, resulting in the growth of ambulatory surgical centers, special tertiary surgery centers and specialty hospitals that treat a single major disease category. These legislative changes encourage the offering of "high-end" services that are increasingly demanded by consumers.

Hospital services define the core features of a hospital's organization. The range of services may be limited in such specialty hospitals as cardiovascular centers or cancer treatment centers, or very broad to meet the needs of the community or patient base, as in full service health maintenance organizations (HMOs), rural charity centers, urban health centers, or medical research centers. Hospital services are usually the most general in large urban areas or underserved rural areas, broadly encompassing many services ordinarily offered by other medical providers.

The health-care sector in the global economy has remained predominantly segmented into national healthcare systems and hence the process of globalization has not progressed as much as in many other services markets. National health-care systems are by and large public-sector-owned and operated by a private sector whose participation varies with the affluence of the particular country. The private sector share of health care in both demand and supply tends to be much higher in developed countries than in developing countries.

The countries of the Organisation for Economic Cooperation and Development (OECD) account for most of total world health expenditure indicative of the level of development, higher per capita income and higher share of GDP spent on health care.

Health care has been largely a nationally-based activity; consequently, health-care units have not been prone to the enlargement that is so pronounced in the private sector and particularly at the global level. The national health-care system run by governments could be construed as a single organization and, unlike the private sector, does not have any impulse to spread beyond national borders and to be involved in strategic cross-border alliances. Similarly, the private sector of these systems displays different tendencies in developed and developing countries. The private medical institutions have exhibited a limited proclivity to merge even nationally, much less internationally. In the United States, however, there has been a growing merger movement among hospitals prompted by rationalization and consolidation. Developments in the United States may portend the future trend in the ownership and operation of private medical facilities. While there is not a worldwide tendency for units in the health-care sector to enlarge or to become transnational in scope, institutions in the United States could pioneer the emergence of transnational institutions.

The growth of health-care expenditure has been extremely uneven with the vast majority of funds being spent by developed country governments and citizens and almost exclusively in developed countries. In contrast the minuscule percentage of global healthcare expenditure, which developing countries account for, is a reflection of demand, constrained by low incomes and inadequate supply of modern medical facilities, equipment and services. Indeed, affluent citizens in developing countries often seek medical treatment in developed countries in particular, for specialized treatment such as that offered by the Mayo Clinic and the Johns Hopkins University Executive Medical Program.

In a recent post to the Health Affairs Blog, Charles Roehrig, an economist who serves as VP and director of Altarum's Center for Sustainable Health Spending, presented some very interesting graphics of long term health care cost growth in the U.S. He shows the often-presented statistic of health care cost as a percent of Gross Domestic Product (GDP) over the 46 year period since Medicare was established in 1965. The climbing graph is bumpy due to the effect of recessions and recoveries on the GDP measure in the denominator. To see the underlying health care cost growth more clearly, Roehrig calculates what the GDP would have been during each time period if the economy was at a full employment state, called the

"potential GDP." He then calculates health care cost as a percentage of potential GDP. This creates a nice, steady upward ramp from 6% to almost 17%.
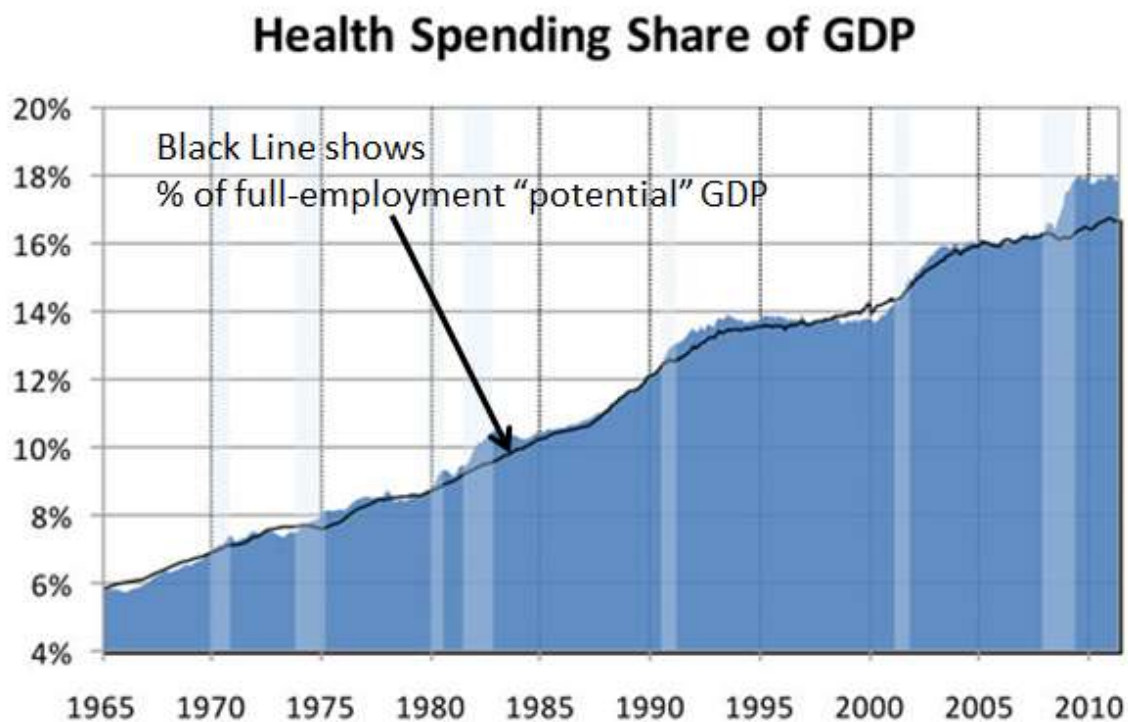
## Health Spending Share of GDP

Black Line shows
% of full-employment "potential" GDP

**Figure 2.1:Health Spending Share of GDPF**

There is no evidence of intense competition in the global health-care industry because the market for health-care services has not yet become truly global in character. The intensification of competition which generally accompanies the increasing dominance of the global market is not a major factor influencing national health-care systems. At the high-income end of the market and in certain specializations a limited number of institutions in developed countries have achieved global reputations as leaders and the demand for their services emanates from all over the world.

While the health insurance entities, hospitals and health-care providers in the private sector of developed countries have experienced consolidation and mergers, there are few genuine multinational corporations in this sector. This is largely because of the significant differences in national regulatory regimes, which have inhibited the global expansion of corporations that are sufficiently large to marshal the necessary human and financial resources to undertake such ventures abroad. The global spread of health-care corporations is likely to take place first in jurisdictions where there has been a standardization of regulations among a group of companies and points of entry will be those countries that make it relatively easy for foreign

health-care providers to establish and operate. However, several multinational corporations involved in manufacturing pharmaceutical and medical supplies have well-established distribution networks in developing countries. Many developing countries, particularly in Latin America and Asia have significant private medical sectors. A substantial number of hospitals and other health facilities are privately owned and even in low income countries more than half of basic health services are provided by private practitioners. Several United States multinational corporations including Aetna, American Insurance Group, CIGNA and Prudential are operating in Latin America. They entered the market in the 1990s by acquiring through purchase or joint venture local companies that provide pre-paid health plans and indemnity insurance (UNDP, 2003). Consortia of corporations and strategic corporate alliances are beginning to emerge; for example, the Apollo hospital group is building 15 hospitals in Malaysia, Nepal and Sri Lanka. The Parkway Group of Singapore, which owns hospitals in the United Kingdom and Asia, has partnered with firms in Indonesia, Malaysia, Sri Lanka and the United Kingdom to form Gleneagles International to operate an international chain of hospitals (Chanda, 2002).

### 2.1.4 Growth of Health Services

Global expenditure on health care in 2005 is estimated to have amounted to US$ 4 trillion (UNCTAD, 1997), with OECD countries accounting for most of this expenditure (WHO, 2002). Spending on health care ranges from 14% of GDP in the United States to 1%-5% of GDP in developing countries, with the OECD countries spending 8% of GDP (Zarrilli and Kinnon, 1998). Per capita expenditure on health exhibits similar disparities ranging from $16 in low-income countries to $2,300 in high-income countries. Despite rapid globalization, particularly in services, there is limited international trade in healthcare services and transborder activity in health care. Most of the international exchange of health-care services consists of purchase of services in developed countries by persons travelling to those countries for treatment. The growth of international trade in health services is accelerating. Cross-border delivery is now worth $140 billion (World Bank, 2005) and is projected to grow at 6% per annum.

Some institutions in developed countries have begun to market their services and facilities internationally thereby boosting the global market. Johns Hopkins and the Mayo Clinics have achieved remarkable growth in foreign patients since they started marketing internationally in the 1990s (Freudenheim, 1996). Referral hospitals in the United States (e.g. Sloane-

Kettering) are institutions of worldwide renown and have an international clientele. A growing number of less prestigious United States hospitals, in an effort to utilize their capacity to the full, have contracts with foreign firms, public sector institutions and trade unions throughout Latin America and the Caribbean (Warner, 1998). An interesting new trend is the movement of consumers in the developed countries to developing countries because they can access treatment, which is less expensive than in their home countries. Another reason for seeking treatment abroad is to avoid extended waiting periods in national health systems and because in some cases they cannot afford private health care (Lunn, 2006). Increasingly, health care and tourism are being combined and have been labelled "sun, sea and surgery" (Prosser, 2006; Sankaranarayanan, 2005).

For example, British citizens have travelled to Spain, Turkey, Eastern Europe and India to avail themselves of medical and dental services at prices which are as much as 50% lower than in Britain.

The health-care sector continues to produce new technologies which complement and enhance but do not replace human skills; for example, computers and lasers have not replaced human beings but improved the efficacy of medical practitioners and simplified the task of care givers. Developments in communications Technology have led to the emergence and growth of telemedicine, which developed initially in national Markets, but is increasingly international in scope. Telemedicine has helped to improve the practice of Medicine in both diagnostics and treatment. Developing countries are turning increasingly to telemedicine to Supplement and upgrade their supplement and upgrade their capability at relatively expensive cost.

Health-care systems are predominantly national and in most cases government is the principal health-care provider and the regulator of the laws governing the health-care system. Naturally the role of the private sector in the health-care system reflects the predominant role of government and its health policy. The twentieth century was marked by the rise to prominence of the social and political philosophy that public health was the responsibility of the State and that the State was best able to execute the task of providing health care to all, and if not to all, then at the very least to those who could not afford private medical treatment. This type of thinking reached its zenith in the welfare State, but was also a firm commitment of socialist countries.

Governance of the health-care sector of the global economy is national with increasing international cooperation through multilateral institutions such as the World Health

Organization (WHO) and regional institutions such as the Pan-American Health Organization (PAHO). This cooperation is necessary because of the ease and speed of the spread of diseases from one country to another. In recent years, Governments have increasingly taken cognizance of international health-care standards and participated in, and cooperated on, international health-care issues such as immunization and the control of epidemic disease.

The health-care sector is far ahead of most industries in the global economy in terms of its multi-ethnic, multicultural character. Notwithstanding the ethics which derive from the "Hippocratic oath", the medical profession was one of the earliest to abandon the notion of national boundaries, as illustrated by the cases of Florence Nightingale and Mary Seacole3 in the nursing profession and more recently, collaboration in research and the international mobility of doctors and nurses.

The mindset of the profession is global given that its subject matter —illness and mankind— is not confined by national boundaries and there is a willingness to live and work abroad. However, national professional certification of medical personnel and barriers to migration make global mobility extremely difficult. Patients tend to feel more comfortable with medical practitioners from their own culture, society and ethnic background. Indeed, many patients are suspicious of foreign medical practitioners in many cases fearing that they are not properly trained or too unfamiliar with local conditions and ailments. For example, Spanish speaking Americans of Latino origins living in southern California often prefer to travel to Mexico for medical attention (Arredondo-Vega, 1998).

### 2.1.5 The growing market for location-based services

As smart phones like the Apple iPhone, Google Android-based devices and Research In Motion‟s BlackBerry have become increasingly popular, so has the use and ubiquity of LBS. Frost and Sullivan predict 20 percent of users will make use of LBS by 2012 [Vaughan-Nichols, 2009]. Juniper Research [2010] has predicted the size of the mobile LBS market to exceed \$12 billion by 2014. Much of this comes from application sales, with mobile advertising set to drive growth over the next five years. These figures show a large and growing consumer market. LBS can provide much benefit for enterprise operations such as asset tracking and locating. Realising this potential, many organisations are jumping on the bandwagon using specialised hardware. However, as more smart phones are deployed into

the enterprise, the advanced sensors and features of these devices, such as inbuilt GPS receivers, can be used to provide even more cost-effective LBS to workers and customers.

Global Positioning System (GPS) typically comes to mind when location collection technologies are discussed. GPS and A-GPS have a clear advantage in terms of accuracy. However, there are several other options available with different accuracies, such as mobile network-based and Wi-Fi-based technologies. Briefly, GPS-based technologies provide highest accuracy at the expense of power consumption. Mobile network-based technologies provide lower accuracy, but since they do not rely on an extra receiver, they use less power. Wi-Fi based technologies sit in the middle of the continuum but rely on Wi-Fi access points to be available nearby. Not all applications require high accuracy; hence, one can save on power consumption and extend a Smartphone's battery life by using a lower accuracy technology. As with all technologies, LBS is now moving towards common standards, allowing application developers to focus on their applications rather than core LBS components. The Open Geospatial Consortium (OGC) is one major group that is developing standards in the LBS space. It has a number of notable members such as ESRI, Oracle, Google, IBM and various US and European agencies.
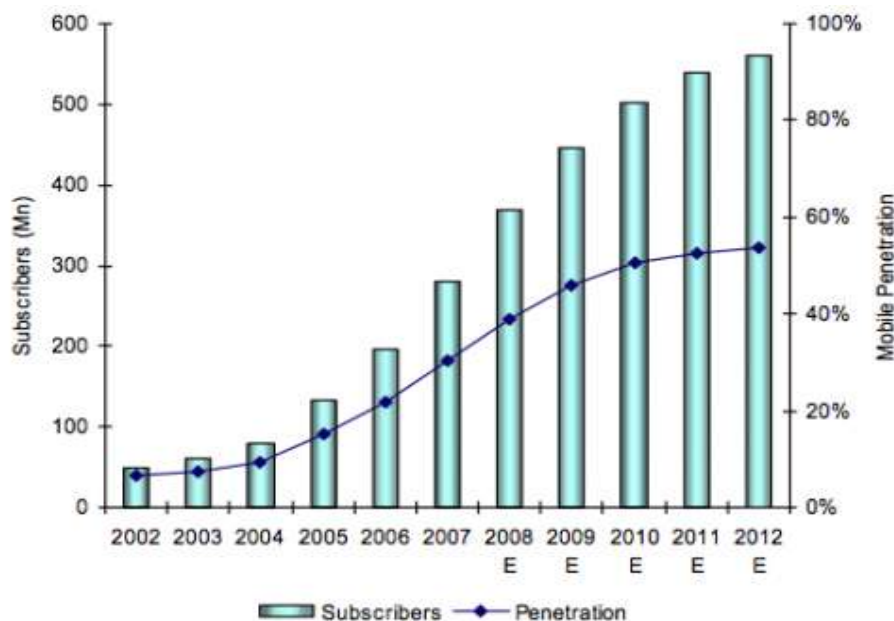


**Figure 2.2 Africa-Mobile Subscribers and Penetration(2002-2012)**

## 2.2 Mobile Technology

According to (Wikipedia, n.d.), Mobile technology is a collective term used to describe the various types of cellular communication technology. Mobile CDMA technology has evolved quite rapidly over the past few years. Since the beginning of this millennium, a standard

mobile device has gone from being no more than a simple two-way pager to being a cellular phone, GPS navigation system, an embedded web browser, and Instant Messenger client, and a hand-held video gaming system. Many experts argue that the future of computer technology rests in mobile/wireless computing.

Mobile computing allows people to use IT without being tied to a single location. Any business with staff that work travelling to meetings, out on sales calls, working from a client's site or from home can make use of mobile devices to keep in touch and make the most productive use of time. Devices used to stay in touch including laptops, netbooks, personal digital assistants and 'third generation' (3G) smart phones. Mobile IT devices can also lead to new ways of working, and new products and services that can be offered to the businesses customers (ico., n.d.).

The (ico., n.d.) also says that mobile computing can improve the service offered by businesses to their customers. For example, when meeting with customers employees could access their customer relationship management system - over the internet - allowing updates to customer details whilst away from the office. Alternatively, customers can be allowed to pay for services or goods without having to go to the till.
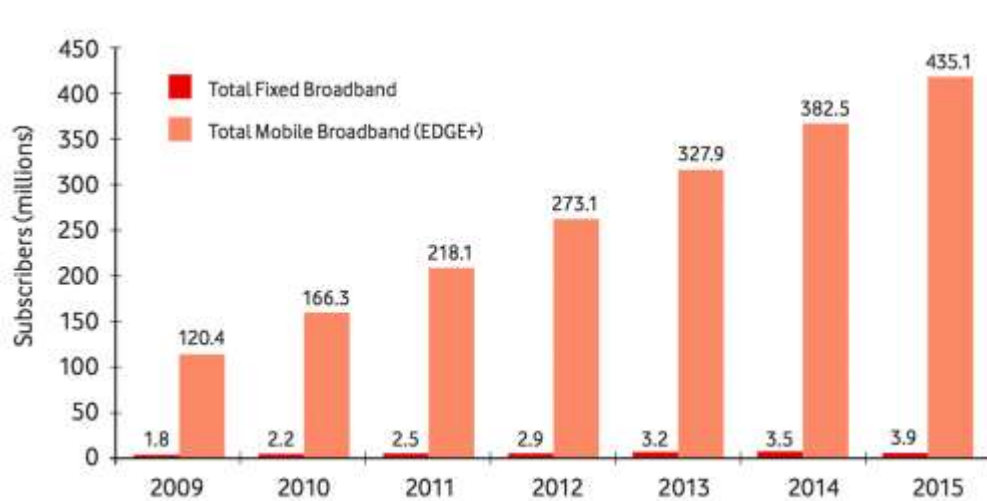


**Figure 2. 3 Total Mobile and Fixed Broadband usage(2009-2015)**

Mobile technology is also increasingly being utilized as a tool for emergency situations, a quick response is critical. The 'golden hour' refers to the short period immediately following the onset of an acute illness or injury, during which administration of appropriate treatment has a significant impact on health outcomes. A 1998 survey of mobile phone users in Australia showed that 12% had used mobile phones to report road accident; 6% to report

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medical (non road) emergencies; 1% to report psychiatric crisis; and 0.14% to report a heart attack, epileptic fit, or diabetic coma.

More recently, a UK study showed that mobile phone use for reporting emergencies has increased from 5% to 29% of total calls from 1999 to 2004 in London, and the use of mobile phone in combination with a locator system was associated with an improvement in response times to accidents and other emergency services in London.

While healthcare providers are struggling to define their social media strategy, many are already developing mobile applications (primarily for Apple OS and Android operating systems). Hospital administrators and clinicians are mobile in their job duties. Nurses, doctors, and home health care agents spend significant portions of their day with patients or in transit between patients. They are not behind a desk with much frequency. Not surprisingly, mobile apps for internal hospital use are very popular. These apps allow administrators and physicians to see scheduling, census, supply cost, and medical records while on the move

However, employees are not the only target audience for mobile apps. Marketing departments are driving new mobile apps as well, to engage their patients more effectively. It is here, in the patient domain, where the greatest opportunities for new business value exist. Today, these mobile apps are intended to improve branding and communication with patients, as well as provide patients tools to improve their experience with the health system. These apps are accessible from their mobile devices anywhere at any time, reducing the friction between the organization and their customer. Examples of popular application functions include.

i.   Disease-specific content (e.g. frequently asked questions regarding maternity, cancer, and joint replacement surgery)

ii.  Tools to manage personal health, including diet calculators, phone-based pedometers, and body mass index (BMI) calculators

iii. Active updates on population health concerns, including H1N1, air quality conditions (pollen, ozone) and tips to control the impact of these

iv.  Marketing of provider-sponsored events, including blood drives, flu shots, and discounted diagnostic screenings (e.g. pulmonary embolism detection, heart scans)

v.   Physician biographies and interactive mapping tools to find a doctor or a hospital

Mobile apps are providing new value to patients, engaging them in new ways with meaningful and customizable benefits. Meanwhile, social media strategies developing from

the idea stage in a separate business unit of the hospital. Both initiatives are intended to drive similar business results – increased market share, increased patient satisfaction, and improved revenue performance. However, in most cases these initiatives are emerging in parallel. Hospitals are lacking a cohesive strategy for merging and monetizing these strategic projects. Kenya mobile telephony industry now accounts for 7% of mobile phone subscribers in sub-Saharan Africa. Kenya had 17.4 million mobile phone subscribers by end of June 2009, translating to 45.7% penetration.

The International Telecommunications Union (ITU) report says Kenya has the third highest number of subscribers, after Nigeria and South Africa that respectively account for 26% and 19% of mobile cellular subscriptions in sub-Saharan Africa.

According to another report by Pyramid Research, mobile penetration in Kenya's telecom market will grow by 95% over the next five years. "Kenya shows impressive growth rates with significant opportunity," notes Dearbhla McHenry, analyst at Pyramid Research and author of the report. "By the end of 2008, Kenya had more than 15 million mobile subscribers, with a mobile penetration rate of 39%. The subscriber base is expected to rise to 29.28 million or 66.7% penetration by year-end 2013

Total revenue of Kenya's telecom market is forecast to grow by 42% from US$1.39 billion in 2008 to US$1.98 billion by 2013, with 78% of the total revenue to be generated by the mobile sector. "Mobile data will be the telecom sector's fastest-growing revenue stream, increasing in revenue from US$62 million in 2008 to US$224 million in 2013, partly due to the launch of 3G services but also to the explosive growth of low-tech, low-margin mobile data services, particularly mobile money transfers," says McHenry.

### 2.2.1 Mobile Computing

Refers to a technology that allows transmission of data, via a computer, without having to be connected to a fixed physical link.(Koudounas and lqbal).The purpose is to provide any client at any time in any location with useful, accurate and timely information. It is one of the far-reaching implication technology growing up with mobile communication, internet, database and distributed computing.

In the near future, tens of millions of people will carry a portable palmtop or laptop computer. Smaller units, often called personal digital assistants or personal communicators, will run on

AA batteries and may have only a small memory; larger ones will be powerful laptop computers with large memories and powerful processors. Regardless of size, 20 most mobile computers will be equipped with a wireless connection to the fixed part of the network, and, perhaps, to other mobile computers.

Mobile computing technologies, combined with systems such as electronic patient records (EPR) and electronic picture archiving and computing systems (PACS), show great potential for improving the productivity of healthcare workers and enhancing the efficiency of hospitals, clinics and other healthcare organizations.
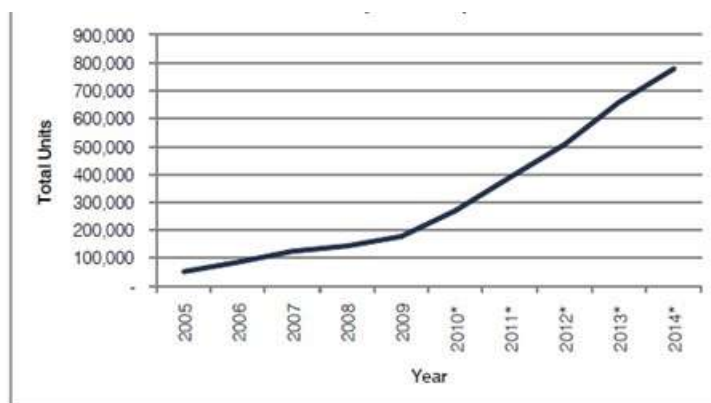


**Figure 2.4 :Total growth of mobile computing(2005-2014)**

George Eliot Hospital (GEH), a 440-bed acute care hospital in England, worked with Intel Solution Services, to test the usefulness of mobile technologies. Twenty wireless tablet or notebook PCs were deployed to a cross-section of care providers. They used the devices with a mobile application portal to access pathology and radiology results, a dashboard application for tracking patient status, and other information sources.

The healthcare industry, conventionally, is recognized as having lagged behind other industries in the use and adoption of new information technologies (IT) and information systems (IS). However, this situation is shifting at a fast pace. Modern IT/IS is an essential tool that fosters and promotes progress in health care and drastically reforms current health care practices. Mobile IT/IS applications in health care can be recognized as both emerging and enabling technologies that have been applied in several countries for emergency care or general health care. For example, a variety of wireless technologies such as mobile computing, wireless networks and global positioning systems (GPS) have been applied to ambulance care in Sweden and emergency trauma care in the Netherlands. Relevant information about the patient (vital information) and the ambulance (exact time and location)

can be transmitted to the hospital in real-time. Therefore, the hospital can be well-prepared for ambulance arrival. In Finland, a system with secure mobile healthcare services was tested in 2003 and was available nationwide in 2004.

This system includes health consulting, electronic prescription, etc. Authorized individuals can easily access the system via mobile devices such as mobile phones Furthermore; health care professionals also need to access and input medical or patient information from anywhere, at any time in their daily ward rounds]. Hence, mobile healthcare systems can facilitate efficient and effective patient care information input and access at the point of patient care. The systems can improve patient care and quality of services, decrease clinical errors, integrate resources, and enable ubiquitous real-time access to patient information and up-to-date medical knowledge. However, most applications, in fact, have failed or have not been implemented as predicted.

Among these, 30% of the failure rate results from non-technical factors, Insufficient user acceptance has long been an obstacle to the successful adoption of IT/IS. Therefore, it is extremely significant to probe the determinants crucial to advance IT/IS acceptance by healthcare professionals. With accelerated hospital competition and the popularity of the Internet and mobile devices, there is a need to understand the factors that would entice healthcare professionals to use mobile healthcare systems (MHS). Comprehending the essentials of what determines healthcare professional MHS acceptance can provide great management insight into developing effective strategies that will allow hospitals to create new opportunities and values for its customers, to increase the efficiency and effectiveness of health care personnel, and thereby, remain competitive. Generally, the essential characteristics of users and technologies in professional healthcare differ greatly from the customary commercial context. Thus, any model developed for the general public may not apply to a healthcare environment.

### 2.2.2 Mobile Health Industry in Kenya

The emergence of m-Health has been shown to reduce the cost of healthcare and increase efficiency through better retention and retrieval of records, better management of chronic diseases, shared health professional staffing, reduced travel times, and fewer or shorter hospital stays. m-Health is not only about telemedicine. Besides telemedicine, m-Health comprises an array of services, including hospital information (medical record) management

system, customer service through internet, medical transcription, and health awareness through portals. a medical record is a very personal document that holds the information of a person's past illnesses, conditions, treatments, and the like, as well as the related medical history of close relatives. Medical records are usually kept and maintained by health care providers, but there are also people who opt to keep a personal medical record. Medical records sound tedious, but they are important because they allow doctors to work quickly, efficiently, and accurately without having to ask the patients for the information they need again and again. A medical record can hold information on the treatments that are recommended for the patient, the care given to certain illnesses the patient has, and the various medication that the patient can and cannot take.

The use of Internet has facilitated access to information anywhere/anytime. The healthcare domain is not left out in this information revolution. Web portals have been equally developed to disseminate health related information and educated healthcare practitioners and the general public.

| Segment | Subscriber(millions) | Penetration (%) |
|---|---|---|
| Fixed-line(3Q 2010) | 0.362 | 0.96 |
| Internet (3Q 2010) | 8.7 | 22.1 |
| Mobile (4Q 2010) | 69.3 | 61.0 |

**Table 2. 1 Kenyan Telecoms Sector(Africa & Middle East Telecom-Week,2010)**

Many subscribers of web services in Kenya are tourist who may not be acquitted with the location where they are using hospitality services on the web infrastructure. Provision of context-aware healthcare services will be a value-added service to subscribers. Users might already have been insured in the national or regional health insurance scheme. This guarantees payment for healthcare services they will receive. If they are not already insured, the proposed infrastructure could be optionally linked with health insurance services for registration of new insurance holders.

Along with 3G and 4G, these advances have had a huge impact on many walks of life. The utilization of smart phones and tablets has transformed communications, commerce, and entertainment, among other fields. Their emergence has improved service delivery,

empowered consumers, businesses, and entrepreneurs, and changed the way in which people access information and make transactions.

| Services | Percentage |
|---|---|
| **Communicating (Email/social media)** | 88.1% |
| Getting information about good and services | 19% |
| Getting information from government organizations, public authorities | 18.2% |
| Reading/downloading electronic books, newspaper or magazine | 19.7% |
| Playing/downloading games | 18.3% |
| Watching movies/TV | 14.2% |
| **Getting information related to health/health services** | **8.3%** |
| Purchasing or ordering goods or services | 6.9% |
| Internet banking | 3.2% |
| Research | 33.2% |
| Other | 3.3% |

**Table 2.2 :Internet use by internet activities in last , June 2011**

Some studies (Free et al., 2010; FHI/USAID & Progress in Family Planning, 2010 in Kenya and Tanzania) focus on the use of mobile health technology in general and developed a conceptual framework that helps track important variables relating to users, providers and nature of messaging. These studies are ongoing and being conducted on a global focus but it is not yet clear on their implication in the Kenya health sector. Osborne (2009) focuses on the successful use of songs and ringtones as a way of communicating with people via mobile phones and providing information on pregnancy and motherhood (Cheek, 2010). Bobock (2010) states that countries such as Kenya and Ghana are focused on country-based leadership can scale up proven programs, develop sustainability, and provide practical and integrated models for cooperation between the government, mobile service providers, the medical community and the private sector.

Ouma and Herselman (2008) in their study on m-Health in rural Kenya note that health workers were positive to m-Health initiatives if only infrastructure, training, cross-sector linkages and government policy are addressed. The latter's methodology was limited to views of hospital managers and staff and left out the Users and policy makers and implementers. Success in mobile and electronic health use in Kenya may need to capture the policy and regulatory challenges to ensure completeness.

There were about 5.3 billion mobile cellular subscriptions worldwide and access to mobile

networks was available to 90% of the world population and 80% of the population living in rural areas (ITU, 2009). In 2008, there were 246 million mobile cellular subscriptions (ITU, 2009) and of these, 21.4 million out of 38.6 million were in Kenya (CCK, 2010; Kenya National Bureau of Statistics, 2010). This growth translates into a nationwide tele-density of 55 lines per 100 inhabitants (CCK, 2010), while the population under mobile coverage stood at 86%, against landline coverage of 36%.

### 2.2.3 Successful Hospital Locating Application

"Hospital plus plus" draws its inspiration from some applications that already exist in the market. Some of these applications include:

i.  **Hospital real-time location systems (RTLS)**

These systems are designed to identify and locate tagged equipment, personnel, or patients as they move through hospital facilities. Tracking equipment has the potential to allow hospitals to manage inventory better, including streamlining the process of routine preventive maintenance, thus improving the availability of needed items and reducing equipment rentals. Tracking hospital personnel aims to document and improve clinical processes, including identifying routine breakdowns in care provision, assigning providers to patients automatically, and disciplining clinicians or other staff who are underperforming in their roles. Tracking patients holds the promise of locating them if they get "lost" as they are moved to various departments within a hospital, verifying their identities before medical procedures, and improving discharge processes to provide quicker turnover of beds. Given these varied uses of the systems, the benefits of implementing RTLS have been characterized as increasing efficiency, improving safety, and reducing operational costs.

According to a 2008 survey of U.S. hospitals, 15% of administrators indicated that their hospitals already had RTLS in place and another 43% expressed their intent to purchase a system within the next two years. The largest hospital technology vendors have now entered the market with their own RTLS hardware or software.

ii. **Wireless indoor positioning systems**

Indoor location sensing systems have become very popular in recent years. These systems provide a new layer of automation called automatic object location detection. Real world applications depending on such automation are many. To name a few, one can consider the

location detection of products stored in a warehouse, location detection of medical personnel or equipment in a hospital, location detection of firemen in a building on fire, detecting the location of police dogs trained to find explosives in a building, and finding tagged maintenance tools and equipment scattered all over a plant.

An astonishing growth of wireless systems has been witnessed in recent years. Wireless technologies have entered the realms of consumer applications, as well as medical, industrial, public safety, logistics, and transport system along with many other applications. Self-organizing sensor networks, location sensitive billing, ubiquitous computing, context-dependent information services, tracking, and guiding are some of the numerous possible application areas. Since wireless information access is now widely available, there is a high demand for accurate positioning in wireless networks, including indoor and outdoor environments. The process of determining a location is called location sensing, geolocation, position location, or radiolocation, if it uses wireless technologies.

### iii.    Health – Ambulance notifier

For people with known medical ailments, who are fragile and home alone, an application was developed to detect when an incident has occurred and trigger an emergency call for an ambulance, with information about the current location and patient details. For example, when an accelerometer detects a sudden fall followed by lack of movement, the patient may be unconscious and hence may need assistance. This type of application reduces emergency response time and be life saving.

### iv.    Health – Doctor's patient list

An LBS was developed to support medical specialists that service multiple hospitals by presenting a list of their patients in the hospital that they are supposed to look after. This included patients that were admitted overnight that doctors were not aware of. The application also provides the exact location of patients, including floor level and bed number. This kind of application improves service levels by reducing patients" waiting time. A feature could also be added to allow users to find nearby medical specialists if additional consultations are required.

### 2.3 Summary

We have looked at hospitals and mobile technology and different aspects related to the two. We have also looked at the hospital industry, the need to improve service delivery there and

how the mobile industry can be leveraged to provide a high impact solution for the masses in Kenya. This could be the innovation that hospitals are looking for to help them improve on their service delivery give them the competitive advantage.

# Chapter 3: Methodology and Design

## 3.1 Introduction

This chapter takes a deeper look at the steps, procedures and methodologies used to design and develop the system.

## 3.2 Research Design

This research seeks to determine how hospitals charge their services; It also determines where this hospitals are located. It also seeks to determine the best design requirements for a mobile hospital locator application.

The Hospital industry is a large and competitive industry that requires the players to continually innovate new methods of improving their delivery of service thereby attracting and retaining clients. All hospitals contain a database showing the services they offer and their prices. The easiest way for a client to know what a particular service a hospital offers is for them to walk in and ask. Some hospitals find it difficult to advertise their location and rely on the people who stumble upon it when passing by, Sometimes people do not go to hospitals because they do not know the services offered and the price charged,hence they miss the offers the hospital could be having.

This research aims to design a mobile hospital locator that can be used in the hospital industry to enhance interaction between the hospital managers and their clients. It will provide a platform for clients to easily access hospital information, provide feedback to the hospitals and easily compare different prices offered by the hospitals. On the other hand the hospital management will have a quick and efficient way to advertise their hospital offers as well as receive feedback from their clients.

The findings of this research will lead to the design, implementation and testing of a mobile hospital locator. The resulting architecture should be able to cater for the needs of the hospital management as well as Kenyan citizens who form the client base of those hospitals.

## 3.3 Data Collection

To accomplish the data collection required in this research, two quantitative methods were used: Interviews and document reviews. These methods provide a good source for accurate information of the scenario on the ground. They are also a good source of information that is relevant in coming up with an efficient and viable mobile hospital locating system.

### 3.3.1 Interview

Interviews were used to collect data from the hospital management (owners, managers, doctors and other staff). Interviews were used because of their ability to provide information about people's attitudes, their values and what they do. The interviewees were selected based on the size of the hospital they operated in as well as the convenience of the researcher in accessing these individuals. The interviews were carried out based on the following open ended questions;

Identify hospital class (Small, Medium, Large)?

How do you think mobile locating system will improve hospital industry?

How do you raise awareness of the hospital offers?

How do you get feedback from the clients?

What would you like to have to help you improve your service delivery?

Another set of interviews were carried out on the ordinary Kenyan. The interviewees ranged from friends, family, classmates, schoolmates and work colleagues of the researcher. The individuals were selected at random and were not required to have any particular attributes to qualify for the research. The interviews were carried out based on the following open ended questions;

i. How often do you visit or go to a hospital?

ii. How do you discover the hospitals around where you live?

iii. What challenges do you face when deciding which hospital to go to?

iv. What would you like to have to help you decide which hospital you should go?

### 3.3.2 Document Review

A review of existing documents addressing hospital industry and mobile technology was done. The essence of this was to understand the history, operations and processes of running a hospital. It was also used to understand past, present and forecasted future influence that mobile technology has on different industries both in Kenya and in Nairobi county. Some

documents used were journal articles of service improvement and trends in the hospital industry, mobile statistics reports filed by the Communication Commission of Kenya, Interviews of successful entrepreneurial hospital owners, reviews and marketing sites of different mobile applications, reports on ICT industry and the Kenya vision 2030 document.

## 3.4 Sampling

The sources of the data were chosen based on the fact that the sample has the characteristics of the target population of the research, and also on the basis of convenience and availability. Using these criteria, the participants of the study were chosen. The number of participants involved was believed to be a good representation of the target groups of population.

## 3.5 Proposed System

A mobile solution "Hospital Plus Plus" is proposed to help improve service delivery in the hospitality industry. "Hospital Plus Plus" is a system that enables users to search for the hospital location and view the prices charged for the different services that are offered.

 It has two interfaces:

    i.    The hospital management web application

    ii.    The hospital locator mobile application

The solution attempts to provide reliable and up to date information on hospitals to users in a manner that is very easy to access at all times.

## 3.5.1 Architecture Overview

The "Hospital Plus Plus" is a three tier distributed architecture. The first layer comprises the application user end. The intermediate layer is more complex. It is composed by several components of the "hospital Plus Plus" architecture. The third layer consists on the data repositories that allocate and implement the services.

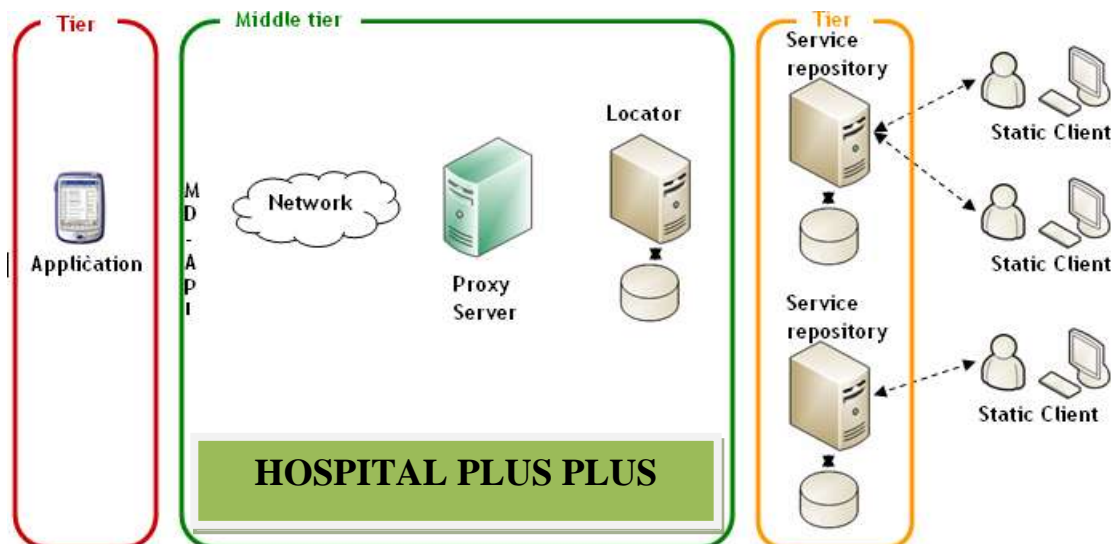The architecture of the system is displayed in figure 3.1 below.

**Figure 3.1 : Hospital Plus plus Architecture**

### 3.5.1.2 MD-API

The application that resides in the mobile device is the entity that interacts directly with the user and offers functions such as service display and data gathering from the user. However, the application doesn't interact with the rest of the components in the architecture. The MD-API is a communications API that mediates between the application and the architecture components. It performs the operations of service discovery on behalf of users providing well defined primitives to access a service. Also, it provides a set of standard functions to manipulate the data delivered by the service in an easy way. The MD-API is considered a part of the middle tier but it resides in the mobile device. Hence, the MD-API hides implementation complexity and communication process to the programmer.

### 3.5.1.3 Proxy server

This component interacts directly with the application through the MD-API. As mentioned before, communications between MD-API and the Proxy Server are implemented by a series of messages that describe the operation and related data that is taking action. The Proxy Server obtains the available services from the service repositories based on the user's current location. Then, it filters the services based on the user profile. In this way, it restricts access to services avoiding the user having to discover them. As can be seen, the Proxy Server models the association between physical location and specific criteria (i.e. security, business models, hierarchy of the user inside of the organization, etc.) to determine the available

services for a mobile user. The basic functions that it performs on behalf of the user are the following.

    i.      Provides the necessary parameters to access a service

   ii.      Keeps track of the available services through an establishment of a temporal session. This session ends when the user doesn't contact the Proxy Server for a long period of time determined by factors such as application nature, user's movement, etc.

  iii.      Acts as a service directory.

To ensure security in all the steps of the communication the Proxy Server encrypts all the information that is sent across the network. Also, we provide a challenge response authentication mechanism between the Proxy Server and the mobile application.

### 3.5.1.4 Locator

This component finds the repositories that might contain available services and locations to mobile users based on their current location. It can be considered as a router that determines to which place the request should be forwarded. To determine this, it uses a set of tables that maps contexts to physical coordinates. To reduce the search time, the location divides a geographical location into zones. Then the zones are divided into sub zones. Finally, the sub zones will match one or more contexts.

### 3.5.1.5 Service Repositories

The context of a service can be physically mapped to one or more service repositories. In this way each repository may contain several services that exist in the same context. In addition the service repositories contain a service descriptor that includes service name, service parameters and some additional information about the service itself. As can be seen from the service repositories include computers that process the queries coming from the mobile device. No matter the implementation of the service, the information retrieved by any service should fit into the message format. Depending on the implementation, a service can also be provided to static users. It is possible that a static client wants to access a service. Although static clients don't belong to the three tier architecture to provide MLDS to users, it is possible for a mobile client to switch to static mode in order to access a now unavailable service or to manually switch context and even access data locally functioning as a disconnected device data would be later updated as soon as communications are established)

Having taken that into consideration, the basic operations defined for a service turn out to be very simple consisting on request, modify and update information functions.

## 3.6 Use Case Model

The hospital administrator will be in charge of managing the hospital services and the advertisements. He will be the one to add hospital details to the database so that users may access them. He will also be able to deactivate any hospitals that may close down or edit the details whenever there is need to. He will also be in charge of adding advertisements to the system. He will also determine which hospital adverts will be displayed to the users.

There are two sets of users: those registered into the system and those not registered. The users initially download the application from the hosting site and at that point in time they are considered as unregistered users. In that state they are able to view the map of the area as required and even select hospitals to view.

Users may choose to register into the service and at this point they become registered users. Not only will they be able to view the hospital map and location but they will now have the ability to rate hospitals and send feedback once logged into the system.

Table 3.1 and Figure 3.2 show the use case model of Hospital Plus plus.

| Actor | Use Case |
|---|---|
| Administrator | Manage adverts |
| Hospital Administrator | Manage Hospitals details |
| Registered Client | Login |
| | View Hospital Location |
| | View Hospital Details |
| Unregistered Client | Register |
| | View Hospital Location |
| | View Hospital Details |

**Table 3.3 Hospital Plus Plus Use Case**
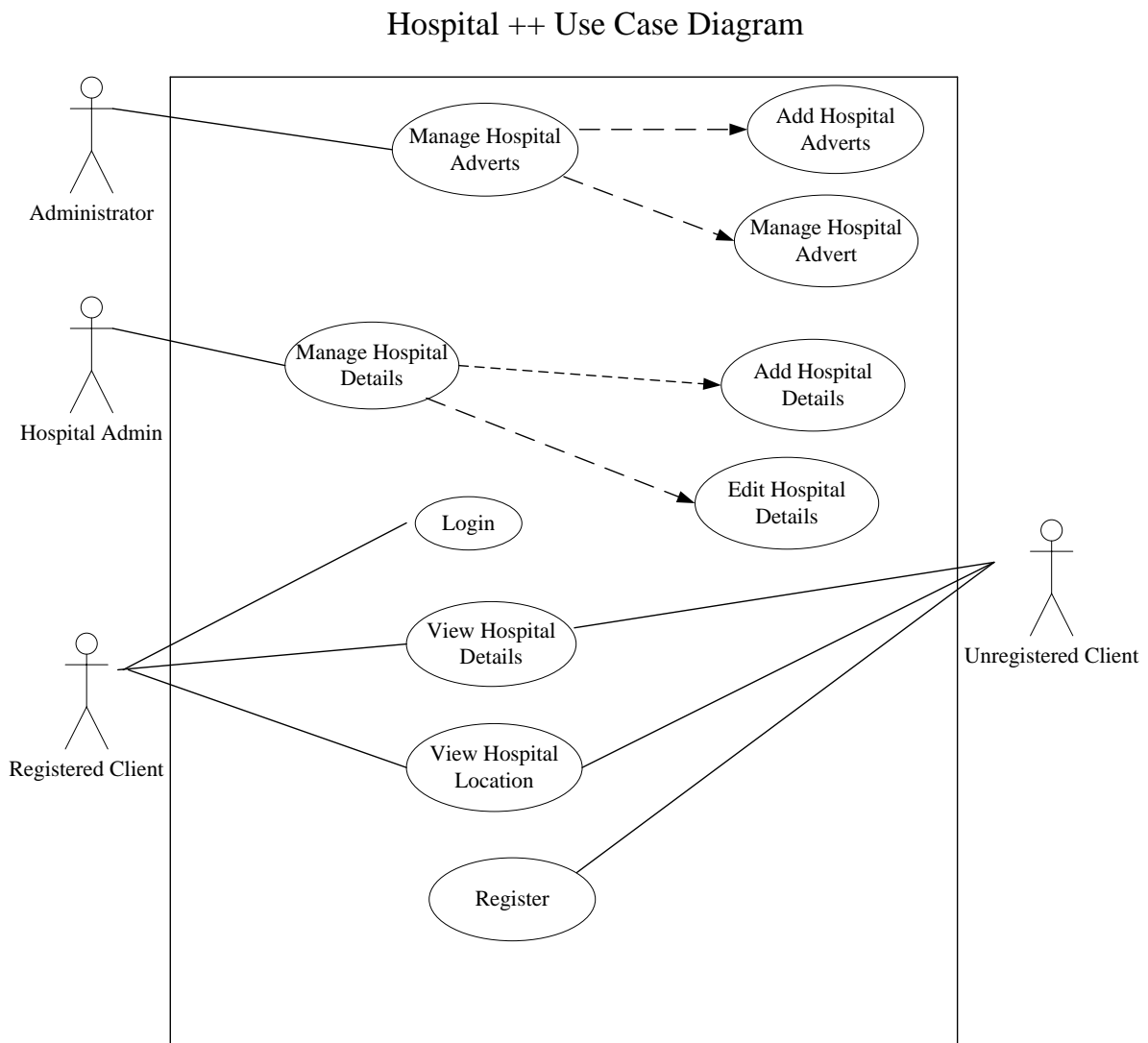
Hospital ++ Use Case Diagram



**Figure 3.2 :Hospital plus plus Use case Diagram**

## 3.7 Interactions between components

Fig. 3 shows the interaction between components and mobile application via MD-API. To start the process the user tries to get authenticated. The application uses MD-API functions to establish a session with the Proxy Server. At this point, all the sides have been authenticated and the communication between mobile application and proxy server is encrypted using a private key schema. After that, the user triggers a service request including his current location and the valid session identifier. The Proxy Server forwards this request to the locator

that in turn determines the available services for that location. The Proxy Server receives this information, filters the services using user's profile, updates his session with the available services, and finally sends the service names and identifiers to the user. At this point the application shows the available services to the user. When a user requests a service for the first time, the Proxy Server requests the service parameters through the locator to the service repositories. This information is sent to the mobile application. The user selects the parameters that she wants to know from the service and requests it. The Proxy Server will validate if the requested service exists for the current user session. If it does, the Proxy Server forwards the service request to the locator that determines the service repository that can fulfill the request. The request is processed and the results are sent to the Proxy Agent which in turn forwards the results via the MD-API. Figure 3.3 shows the interactions
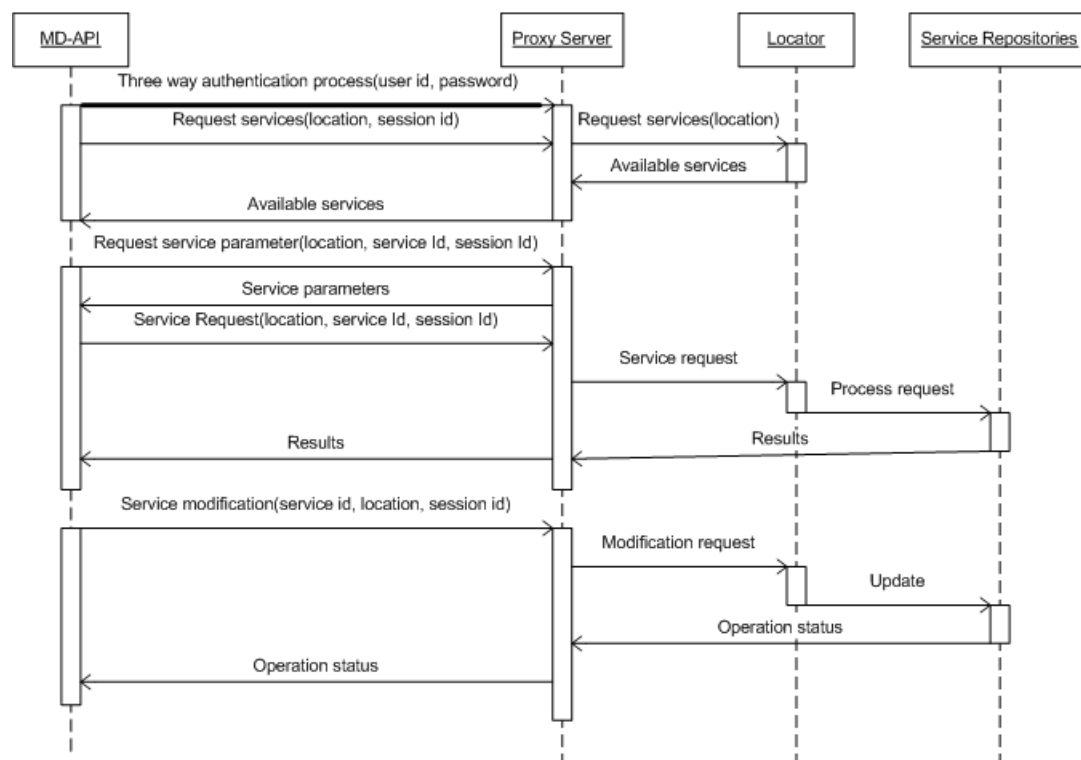


**Figure 3.3 : Hospital plus plus System sequence diagram**

## 3.6 Summary

In this chapter we have seen the research design and research instruments uses as well as the system design diagrams. We have gotten a better understanding of the whole design process that the research employed to build the hospital locating application.

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